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EDITOR & PUBLISHER: WALTER KING. OFFICE: 11, BOLT COURT, FLEET ST., LONDON.

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EDITORIAL NOTES—GAS, &c.

Kindred Competitors.

THE proceedings at the meeting of the British Association were marked by the prominence given to the competitors of town gas in the business of fuel supply to gas-engines. There were three papers read having relationship—one by Captain H. R. Sankey, on the "Utilization of Peat for "Gas Making," the second by Mr. Emerson Dowson on "Producer Gas," and the third by Mr. P. W. Robson on "Suction-Gas Plants in Combination with Gas-Engines." The question of the utilization of peat for the production of gas for power purposes has for the greater part of the gas industry barely more than academical interest, inasmuch as, whatever may be the future developments, the propositions in this regard can only ever attain, from the very nature of the raw material, a local practicability in comparison with the dry material—coal—of more prolific and richer product. But the other two papers force once more upon attention the activity of those associated with the low quality gaseous competitors of town gas in advertising their wares, and more particularly the aspects of those wares in point of economy and efficiency. We will, without stint, give to those who are interested in the technical and commercial development of these competitors credit for research and propagating work unmatched, in connection with power service, in any way by the town-gas industry. Data as to mechanical and thermal efficiency and economy in cost per brake horse power of engines run by producer and suction gas are published with almost amazing frequency. But, in connection with the gas industry, there has been no actual systematic and positive research into these matters; and the gaseous competitors are allowed to publicly have all these things much their own way. The published information does not cover all the points in the tale; but the gas industry allows judgment to go against it by default. The answer to this accusation will be that the more practical and commercial course has been taken of bringing down gas prices for power to what, all points considered, is regarded as a competitive level. That is good, but not sufficient. What is wanted is an authoritative answer, point by point, to the case for isolated producer and pressure or suction gas plants, in favour of town gas. The answer can be given, and ought to be given—not in general terms, but definitely from a thorough investigation. Of this there is certainty—that, in gas-engine research and in the commercial campaign for power business, the town-gas industry is being largely isolated, and left to its own resources, by gas-engine makers and investigators, as though it had now no claim to further participation in it. It must be admitted freely that the blame for all this largely rests with the gas industry itself.

We have to thank Mr. Dugald Clerk for—we think alone among the speakers—saying, at the British Association meeting, a good word for town gas in relation to power business. Mr. William Crossley had also a word to say in regard to it; but it was not altogether complimentary, and we hope and believe was said under a misapprehension as to the facts. This gentleman stated that gas managers had threatened to boycott customers who installed suction-gas plants, and refuse them a supply of coal gas. Although information comes to us of most happenings in the gas industry, we have never heard of a threat to organize any such boycott. What we have heard of, and what has been advocated in these columns, is that gas suppliers should be granted reasonable protective and compensatory powers in connection with the demand for a supply of gas which is destined to be merely treated as a stand-by, in the same way that rights have been granted to electricity purveyors. From what we know of the broadness of the views of Mr. Crossley, it is not believed that he, on consideration, will be disposed to question the fairness and the justice of this. As the law stands now, unless there is mutual agreement for some reward for the accommodation, a manufacturer can, within certain distance limits, ask for a service, sufficient for his power requirements, to be laid on and a meter provided, all at the expense of the gas supplier, who can demand nothing more than the rental for the meter. The manufacturer proceeds to instal suction-gas plant, and may never, excepting when mishap occurs to the latter, make use of the town-gas supply. The gas supplier has a certain amount of capital and labour expense involved in making provision for the supply, he has to be prepared for all haphazard demand upon his mains, and he stands as a protector to the manufacturer, to whom such service is worth some consideration beyond the meter-rental. The gas supplier does not want to be in any way extortionate in this matter, nor does he wish to penalize the manufacturer for adopting a competitor with the town gas-mains; but he does ask that the service he renders shall not go unrequited.

If this is the matter that Mr. Crossley describes as "boycotting" and "refusal" to supply, then the terms employed do not suit the facts nor the law. The compulsory powers are at present with the manufacturer, not with the gas supplier. In fact, it is only where industrial premises are situated beyond the statutorily specified distance from the mains that the supplier of gas can, under existing Acts, "refuse" a supply, unless the occupier is prepared to pay his share of the cost incurred in coupling-up the premises with the gas-mains. It was in connection with Mr. Crossley's accusation that Mr. Dugald Clerk put in a word for town gas. He has not, like ourselves, met with the opposition from town gas suppliers to which Mr. Crossley refers; on the contrary, he has found a disposition on the part of gas suppliers to meet the competition of the newer rivals by supplying gas of good value in heat units per cubic foot at a much lower price than formerly. On this point, he recalls to mind the lecture that he delivered before the North of England Association of Gas Managers in 1905, in which he warned the gas industry that, unless the prices of gas for power purposes were reduced, town gas would be squeezed out of this field by electricity and producer or suction-gas plants. The warning has not gone unheeded, though much more has yet to be done, and will be done, when there is greater relief from the thraldom of illuminating power standards and manufacturing processes have been developed that will give greater gas volume, with good calorific value, per ton of coal carbonized. The cost of the heat unit supplied for gas-engine work by town gas has already been considerably reduced; and there is comfort in the knowledge that the gas industry is on the highway to still further reduction. Meanwhile, where prices are reasonable for power purposes, town gas has much to show in advantage of which producer and suction-gas plants are totally destitute.

Abstracts of the three papers alluded to in the opening paragraph were published in the "JOURNAL" last week; and there is no occasion to specially discuss them now. But two or three matters may be pointed by brief reference. From the peat-gas paper and the discussion upon it, it is easy to see how much theory and how little practice underlie the optimistic views that are held by a few regarding the commercial prospects of the utilization of peat for gas production for power purposes, with secondary product recovery. Estimates and calculations are based largely upon laboratory experiments and small trials. Financial success depends in no small measure upon the recovery of sulphate of ammonia. But just look at the figures given by Mr. Crossley in the discussion [p. 779] as to the capital and working expenditure involved, and the calculations he made as to profit, allowing a nitrogen content for the peat of 2·2 per cent. and (for Irish peat) 1·8 to 1·6 per cent. It is readily seen from the calculations how quickly the profit he arrives at on the working, taking these bases, would be

wiped out by a variation of the nitrogen content in the lower direction. Captain Sankey in his paper pointed out that great care must be taken in selecting the bog from which the peat is extracted, since some analyses show as little as 1 per cent. of nitrogen. This indicates that, within easy distance of the plant, peat of the richer nitrogen value may soon be worked out. Where will these estimates showing attractive profits be then? Another uncertainty is the cost of getting the peat; and this cost will be an increasing one the farther from the seat of operations that it has to be worked. Truly, the uncertainties and the commercial risks of these peat-gas schemes—such as the one that it is proposed shortly to carry out in Ireland—have not yet been fully fathomed.

Interesting to gas engineers is Captain Sankey's argument in his paper in favour of small units of gas-power plant. The lines of the argument are well worth noting by readers. Among the points in the other two papers, Mr. Emerson Dowson made it perfectly clear that of the two rivals—pressure-gas and suction-gas plants—the former is his favourite. The calorific power of pressure gas made with a jet of superheated steam, he says, is usually higher than that of suction gas; for heating purposes in small burners, or in blow-pipes, pressure gas is also better; while an engine working by suction gas develops a rather lower maximum power than with pressure gas. Upon all three of these points, it may be said here that low-priced town gas is the superior of the gas from the pressure plant. Where several engines are to be supplied, it is proposed that greater regularity of gas and simplification will be obtained by the use of a gasholder than by coupling-up a gas plant to each engine. There is no doubt about this; but there is the question of cost to be considered, as well as that of reliability. "Several "engines" suggest big power operations; and it is not always a wise or safe proceeding to put all one's eggs in one basket, when much depends upon the eggs. If the gasholder is at the town gas-works, there is not the same amount of risk, either of stoppage of supply or of variation in quality. From the remark in Mr. Robson's paper that "there is a "prospect, when the possibilities of the suction-gas system "become more fully understood, that its application will be "increasingly extended," it is gathered that the suction-gas system has not made that pace in its commercial progress that its advocates at one time anticipated. The difficulties we venture to believe will, if the gas industry evinces an enlarged zeal in the matter, be characterized in the future by still greater rigour than they have been in the past.

The British Photometric Standard.

THE importance to gas engineers of a precise photometric standard has waned in one respect in recent years, because of the deposition from its former high estate of statutory testing of the illuminating power of gas as supplied by authorized undertakings. But it has waxed meantime in another respect, because of the prominence now given to the testing of the relative efficiency of different types of burners and lamps as means of illumination. The gas engineer must be prepared to say by how much certain high-power gas-lamps exceed in illuminating duty the whilom unrivalled electric arc lights, and to what extent his competitors in the public lighting business are ascribing a fictitiously high value to the latter. It is on these grounds that he maintains a live interest in the photometric standard, and that consequently the report, which we reproduced last week (*ante*, p. 713), on the "Photometric Standard of the National Physical Labora-"tory," by Dr. R. T. Glazebrook, M.A., F.R.S., the Director of the Laboratory, will attract his attention.

The report is of the nature of a confession and an apology—a confession that those responsible at the National Physical Laboratory for the researches made there on the variation of the light of the Harcourt 10-candle pentane lamp with changes of atmospheric pressure and humidity were unwilling or unable to make accurate determinations of the degree of humidity of the air, and an apology that, as a consequence, results and recommendations were presented in the name of the Laboratory to the International Committee on Photometry last year which are now known to have been misleading. Briefly, it is recorded that a degree of humidity which was formerly estimated by the Laboratory as equal to 10 litres of water vapour per cubic metre of air was in reality only equal to 8 litres. It seems almost incredible that an error of 20 per cent. in an estimation which is susceptible of a high degree of accuracy should be confessed to in the research work carried out at the National Physical Laboratory. Moreover, we are by no means satisfied that the course which the Laboratory proposes to follow in future is much more satisfactory than that which has led up to the present humiliating confession. Formerly the Laboratory computed the humidity from the readings of an ordinary wet and dry bulb hygrometer by "the usual formula." It is now proposed to adopt an "Assmann ventilated wet and dry bulb "instrument," which "may *probably* be taken as giving the "more nearly correct result." The word which we have italicized leads us to wonder if the National Physical Laboratory has in any degree taken to heart the lesson taught by the blunder which it is confessing in the same breath. Before adopting another instrument from the readings of which to compute the degree of humidity, it might at least have assured itself that there was more than a bare probability that the instrument gave a more nearly correct result. Has it tested the Assmann instrument? If so, what are the mean and extreme variations of its readings from the truth? On the face of its present proposal, it would seem as though the Laboratory is content, without investigation, to adopt an instrument of which we doubt if it or many physicists in this country had heard prior to last year, although we believe it dates from 1892 or earlier. The Laboratory should clearly understand that in research and standardization work there is no scope for instruments which may *probably* give a *more nearly* correct result, unless indeed the limits of accuracy of determination by any method have already been attained by them. Instruments of the class can only be employed legitimately in research work, as time-savers, after their errors have been accurately determined, so that allowance may be made for them.

The proposal to adopt 8 litres of water vapour per cubic metre of air as the standard condition of atmospheric humidity for the Harcourt standard lamp might be accepted if it were clearly understood that this was an absolute quantity, as determined by the most precise chemical or physical method. But the condition of atmospheric humidity which appears as 8 litres per cubic metre when computed from the readings of an instrument which probably gives a more nearly correct result than one differing from it by 20 per cent., cannot for a single moment be accepted as standard. Having regard, however, to the inexactness of its past work which is now disclosed, we think that the National Physical Laboratory need not hesitate to face a more drastic revision of its earlier proposals, and enter into negotiations with the Paris and Charlottenburg Laboratories with a view to the same standard degree of humidity being accepted for the Hefner and the Carcel as for the Harcourt standard. But it must anyhow be an absolute degree of humidity, and not one stated in terms of the readings of a particular instrument whose degree of accuracy or inaccuracy falls only within the range of vague probabilities. Agreement as to a standard degree of humidity for photometric standards would constitute a great step towards the international unification of standards of light. A step farther must ultimately be taken, and agreement arrived at as to a standard atmosphere for the photometric standard, not only in respect of the degree of humidity, the temperature, and the barometric pressure, but also in respect of the proportion of carbonic acid and oxygen contained in it.

Petulant Parliamentary Agents.

ONE of the pleasures of a long journalistic record in the gas industry has been the, until now, unbroken amicable relations that have existed between ourselves and those who carry on the responsible functions of Parliamentary Agents. Probably all so professionally engaged have not always been in agreement with our expressions of opinion on matters in which they are concerned. It cannot be expected they should be. From the "JOURNAL" standpoint, the broadest possible view has to be taken of the interests of the vast gas industry and its patrons as a whole; while the field of vision of Parliamentary Agents is naturally bounded by the interests and opinions of their individual clients and by the ground those clients occupy, whether as promoters or opponents. Parliamentary Agents, as a rule, have recognized this difference in our relative positions; and criticisms that have been made of the Bills under their care have been taken with good grace, and without any show of peevishness or animosity on their part. They have recognized fully and freely that our comments are directed to matters of industrial and public interest; that they are made quite impartially, and with an absolute in-

difference as to who are the promoters, the parliamentary agents, or others engaged in connection with the measures. This independence (which will be maintained and continued under any circumstances), we are happy to know, has not, through broadmindedness, caused any split in friendly relations, until just lately; and even this sole instance we regret on account of the puerility and petulance it reveals, and in a quarter where it was least expected.

For what have been magnified into enormities in the way of criticism, there is an attempt at chastisement by one firm of Parliamentary Agents—Messrs. Baker and Co.—in the shape of a discontinuance of the courtesy hitherto unfailingly extended to us by the whole of the Parliamentary Agents, of providing for review copies of the Bills and Acts in which our readers are interested. We decline to cry "*peccavi!*" for legitimate criticism and performance of duty. The firm named, contrary to what has been most willingly done by all the other Parliamentary Agents, refuse to give us for review copies of the Gas Acts of the past session in which they are concerned. We do not feel greatly injured as a consequence, as the office of Messrs. Baker and Co. is not the only source from which copies of the Acts in question can be obtained. One would think from the tone adopted by that firm, in declining to supply us with copies of Acts that we required from them, that our criticisms were prompted by malice. Let us inquire into this. In the past session, the firm only had, so far as we remember, three Bills in which gas was referred to; and, in our notices of these Bills when deposited, nothing appeared that could possibly cause the slightest resentment. One of them was the Swinton and Mexborough Gas Bill. When it came before a Commons Committee last March, the proceedings disclosed a condition of past management that justified the Committee, after very careful inquiry, in imposing a purchase clause. Comment was made on the matter; but that comment was not of a character that vindicates the petulance exhibited by Messrs. Baker and Co. Had the Bill been under the pilotage of any other firm of Parliamentary Agents, our criticism would not have been changed in tone. Going back to the session of 1907. The new illuminating power model testing-clauses had then come into existence; and we called attention to all cases of Bills prescribing the "London" No. 1 burner for the testing of 14-candle gas. Unfortunately for our peaceful relations with Messrs. Baker and Co. (though we did not then suspect that so small a matter would have such inflammatory effect), they were agents for three Gas Bills that proposed the old 16-candle standard burner for 14-candle gas; and the fact was, of course, mentioned—it being the policy of the "JOURNAL" to do all possible in the way of advocating a system of gas-testing that might have, under modern conditions of gas supply and utilization, a universal application. Though on that occasion Messrs. Baker and Co. protested against what we said, the three Bills in question were, during their course through Parliament, brought up to date in respect of the testing-clauses. Is more wanted to justify the attitude we then took?

For these simple offences, Messrs. Baker and Co. seek to punish us in a manner the pettiness of which arouses at once amusement and sympathy. We hope that the umbrage they feel will quickly die out, as in a few short months, if the firm are agents next session for any Gas or Water Bills, it will be necessary to obtain copies; and if they cannot be procured in the customary way, an explanation will again be necessary in these columns. However they are obtained, if there is anything about them that calls for criticism, criticism will be made—just as it will be in the case of other agents' Bills. We risk, in maintaining our independence, such antagonism as has been shown on this occasion; for that independence we do not intend to sacrifice, nor allow anyone to fetter.

Labour and Arbitration.

THE air is again charged with labour topic. Heavy clouds hang over the north in connection with the question of wages in the cotton industry; and a memorandum setting up a fresh tribunal for producing pacification in industrial disputes has been issued by the President of the Board of Trade to Chambers of Commerce and labour organizations. This simultaneity has caused a closer public examination of the latter than it might otherwise have received. We are not among those who are disposed to sneer at any scheme of arbitration or conciliation which will help to bring calm to troubled waters; but like the application of oil for that purpose, all such means—optional, and the award having for support only an honourable obligation—have nothing about them that gives confidence of permanent effect. Conciliation Boards are common in industry to-day; and they have done excellent work. The fact exists, and therefore cannot be controverted. While the functions and practices of these Boards are not to be interfered with, nor the voluntary and permissive character of the Conciliation Act in any way impaired, it is considered by the President of the Board of Trade that the time has now arrived when the scale of the operations of these bodies deserves, and indeed requires, the creation of some more formal and permanent machinery, with the view to consolidating, expanding, and popularizing the working of the Act. The proposal of Mr. Churchill is, therefore, to set up a standing Court of Arbitration, consisting of three or five members according to the wishes of the parties. The Board of Trade will nominate the Court from three panels. The first panel—of chairmen—will comprise persons of eminence and impartiality; the second will be drawn from the employer class; the third, from the class of workmen or Trade Unions. This recognition of Trade Unions is a politic stroke, and will do much to favourably commend it to the less militant of labour organizations.

That, in fine, is the plan. Will it be generally acceptable by those whom it is intended to serve? The memorandum states that careful inquiry by the Board of Trade leads to the conclusion that such a Court will not be unwelcome in industrial circles. The statement is not distinguished for definiteness; and already there are substantial indications that in trade circles the scheme is looked upon with marked misgiving, with doubt as to the necessity, and with suspicion that it is the last step before arriving at State interference in industrial dispute. As to the necessity, the Conciliation Boards, as has been said, are doing excellent work so far as is within their power. But it is believed that the standing Court of Arbitration will render the labours of these Boards all the more arduous and indeterminate by the knowledge of the parties that there is, so to speak, a court of appeal behind them. It is true that arbitrament by the Standing Court can only be invoked by agreement between the parties in dispute; but the formal and permanent character of the Court, which casts the shadow of suspicion as to its being the last step before compulsory arbitration is put into force, will, there is fear, cause it to be distasteful to trades unionists when they come to give the scheme collective and serious consideration. Trades unionists have deliberately set their faces against anything in the form of compulsory arbitration; this being established by the ignominious rejection of the proposition on the subject at the recent Trades Union Congress. Compulsory arbitration has proved its weakness in Australia and New Zealand; and a Bill is now before the Legislature in New Zealand which is highly offensive and irritating to labour through the proposition embodied to effectually destroy its liberty in the matter of striking, with the accompaniment of compulsory arbitration. Striking it is intended to make a penal offence, with special penalties in certain industries such as gas, electricity, water, coal, and those providing the necessaries of life and traffic conveniences. Compulsory arbitration, without striking being made a penal offence, has in these colonies proved to be, in certain cases, absolutely worthless; discontent with awards having been made a reason for striking. Now, however, that it is contemplated to impose a stronger restriction upon workers and their Unions, there has come the severest hostility, both from labour and those who sympathize with the principle of an equality in freedom for labour and capital.

We may utter truisms by the score as to the wickedness of strikes and the miseries following in their train, we may call to mind black weeks in the history of the struggles between capital and labour; but to no purpose. Labour will not, while the gulf between capital and labour is so broad and deep, give up what is cherished as the most effective weapon of not only offence but defence. We must therefore restrict the gulf to the narrowest and shallowest limits; and to do so we have to get down to the very root of the evils that have produced the widening and the deepening of the separating abyss. Arbitration and conciliation boards, Sir George Livesey has often said (and his view is not changed by Mr. Churchill's scheme) are all very well in their way; but at the best they are only palliatives. The desideratum is unity of interest between capital and labour. Prevention of a disease is always to be preferred to the cure, which may only be temporary. Then, while we welcome any scheme that will tend to modify the bitterness and to make less stringent the animosities of industrial warfare, let us try to exterminate the

evils that produce the troubles. The process of extermination has set in with much real earnestness in the gas industry. May the good work spread.

Company Promoters and Shareholders' Lists.

A CLIQUE of company mongers, whose existence the gas industry proper has much cause to regret and even resent, have again been worrying (by agent) officials of certain gas companies for lists of the names and addresses of shareholders. The object for which they require these lists is to extend the range of the circulation of their specious prospectuses of liliputian concerns with ill-fitting capitals. The *modus operandi* of these people in attempting to obtain these lists of shareholders is well known. One of their number or one of their satellites purchases a few shares or a small amount of stock—just sufficient to constitute him a shareholder; and then, as a shareholder, he applies to the Secretary of the Company, under section 10 of the Companies' Clauses Consolidation Act, 1845, for a list of the shareholders. In some cases, the connection of the applicant with the promoting gang is not divulged by his name. He may be simply the Secretary, or hold some other office, in one or other of the several Companies that have been promoted, floated, and unprofitably carried on on money obtained from the public mostly through sheer artifice. If the Directors and officials of the Company concerned decline to comply with the application, then a solicitor's letter is forwarded, calling attention to the fact that the shareholder in question is—being prepared to pay the fee—within his right in requiring a list of his fellow-shareholders; and that he (the solicitor) must insist on compliance. This intimation from a man of the law has often had effect; but, we rather fancy, not always. In fact, our firm opinion is that neither the promoters nor any of their satellites would care—perhaps dare would be a better word—to pursue a Company into Court to compel the preparation of a list.

Section 10 of the Companies' Clauses Consolidation Act, 1845, provides for the keeping of a book containing the names and addresses of shareholders; "and every share-"holder, or, if such shareholder be a corporation, the clerk "or agent of such corporation, may, at all convenient times, "peruse such book gratis, and may require a copy thereof "or of any part thereof; and for every hundred words so "required to be copied, the company may demand a sum not "exceeding sixpence." Non-compliance with a request for a copy by a shareholder—whatever may be his known character, and whatever may be his known object—would be a technical offence. The clause mentions no restrictions or exceptions; so that the purpose for which the list is required is not the business of the Company or its Directors or officials. There is another point, the clause names no time in which there must be compliance with the request; and therefore, if there is not point-blank refusal, officials must not allow themselves to be harassed or bullied until they have taken counsel with their Boards. Further as to refusal constituting a technical offence, it is worth while sometimes to commit a technical offence; and this appears to be such an occasion. The clause names no penalty for non-compliance; and, as said before, we doubt whether the people directly interested in these promoting transactions would be desirous of pressing for any washing of dirty linen in the Law Courts. This being so, we should be inclined on receipt of a solicitor's letter to bid him and his client to do their worst, with the knowledge that their worst would not be very back or heart breaking.

This is a matter that the Gas Companies' Protection Association might well take up, if a way can be found; or if, as an Association, they have any scruples, or have such respect for the law as represented by an enactment made over half a century before such troublesome parasites cropped up in the gas industry, and would not be prepared to assist in any defence of its infraction, it would be an excellent thing if gas companies would league themselves to snap their fingers at these requests by such company promoters and their minions though small shareholders (shareholders only for a specific purpose other than investment), and jointly bear the result, which, in our judgment, would be of quite a negative character. The Chairman of the Gas Companies' Protection Association (Mr. H. E. Jones) has had some experience with these people; and, though we are not sure, we have an idea, that one or more of the Companies with whom he is connected have resolutely declined to hand over a list of their shareholders to an applicant known as one, or an associate, of these promoters. To take united action, with a resolve to stand together firmly in the matter, requires a prime mover. Here is the suggestion; the time is opportune. Considerable damage has been done already; and there is a great deal of purification required. The work is such that we need not be very particular about the means employed in assisting in it, even though there be violation of a section of an Act, which section events show lacks a safeguard in the public interests.

More Capital Wanted.

There is a singular omission in the prospectus inviting the public to complete the "authorized" capital of the East Sussex Gaslight, Coke, and Water Company, Limited, in that there is no mention in it of No. 99, Cannon Street, and those who mainly direct affairs from that quarter. Is it that the address and names are no longer attractive? Let that pass, however. It is a feature of the recent prospectuses of the concerns that have had their origin at that address that they seek to draw in the whole of the balance of the authorized capital. In the present instance, those investors who are satisfied with a prospectus that contains much excepting actual statement as to the business done by the Company, the profits (if any) made, and the dividends (if any) hitherto paid by the East Sussex undertaking, and who make application "on or before" next Saturday, will be subscribing to the substantial balance, for such a concern as this, of £8735 out of the total authorized capital of £25,000. Thus the sum of £16,265 has already been issued; but there is no account in the prospectus as to what the Company have got to show for their money, nor what the money has been earning (see *ante*, p. 377). They have had no water-works to construct, as the water is purchased in bulk at 6d. per 1000 gallons. But while the Directors—two of whom, whose names have been seen before, A. Maclean, Barrister-at-law, and F. Jenkins (Capt.), D.S.O., sign the prospectus in company with H. P. Davis, Secretary—withhold positive information about the Company, investors will no doubt be duly impressed with the information that a sewerage scheme has been completed in the district, and that Lord Brassey, K.C.B., cut the first sod of a water-works that does not belong to this particular concern, but we believe to another one from the same brood. Anyway, the now well-known form of seduction is again practised. In red type at the top of the prospectus, readers are informed that "the shares subscribed for and allotted on this issue are entitled to the quarter's interest at the rate of 5 per cent. per annum, payable on Oct. 1, 1908." Investors must not be misled by the "Important Development" announcement, from which it is gathered that the Directors are going to pay a royalty of 1s. 6d. per 1000 cubic feet to the London, Brighton, and South Coast Railway for any natural gas taken by them from the celebrated Heathfield well. Others who have dabbled with this natural gas business at Heathfield have (financially) burnt their fingers over it. According to a report made by Mr. D. Wallace Heims, "M.E.," on the subject, he states that during his acquaintance with this borehole it has produced natural gas equal to a volume of 2,452,800 cubic feet! How remarkable! How long the "acquaintance" of Mr. Heims and the well has continued is not stated; but such a quantity of gas, in the eyes of gas people, is of somewhat modest amount. With regard to the calculations of these people as to the profit to be made on this natural gas, natural gas does not possess the property of finding its way from a well to the consumers' burners without costing something in addition to the royalty and the upkeep of the well.

The Desire to be Free.

Once more, at a particularly opportune moment, has the annual report of the National Free Labour Association made its appearance. With the threats of trouble in the railway world, the long engineering struggle on the north-east coast, and now the combined movement in one branch at least of the cotton trade, it is of particular interest to be reminded that there is an Association to which those men can appeal who desire freedom to dispose of their labour on such terms as may be agreeable to themselves. It is now sixteen years since the Association first issued an appeal direct to working men—urging them to make a stand against any further encroachment upon their rights through the tyrannical policy and tactics of the Trade Unions.

Since then great progress has been made by the organization. During the past year, no less than 45,000 workmen were registered; while 182 employers made application for men. Thus, it is remarked, "the work and status of the National Free Labour Association as an agency for the supply of competent workmen has been fully maintained; the chief and district offices being daily engaged in registering non-Union labour, and sending men to employment with subscribing firms." In the event of disputes, special efforts have been put forth; the Association, when necessary, taking the men personally to the works concerned. In many instances also men were held in readiness to proceed to places where disputes were threatened, thus enabling the employers to adopt a firmer attitude than might perhaps otherwise have been possible. It is stated that, to replace members of the Amalgamated Society of Engineers who are out on strike on the north-east coast, the Association supplied no fewer than 1264 mechanics, all of whom are still giving satisfaction. Such an organization may be well worth bearing in mind by employers generally; for it is never possible to be absolutely certain as to which particular branch may be next chosen for the aggressive attentions of Trades Union officials. In the concluding portion of the report, it is remarked that it is slowly but surely dawning upon the industrial mind that the value of labour cannot be measured by any other standard than that which regulates every product of labour—namely, supply and demand—and that it cannot be made effective to its full capacity unless there be perfect freedom in its application to productive purposes, restriction obviously injuring its value as a wage-earning force. Well, the lesson has been long, and in only too many cases bitter; and even now it is not one that by any means everyone has learnt.

Coalite Hints.

Says the "Financial News," "it would be much better if the hints with reference to the Coalite group, which are being spasmodically conveyed to the public through the City columns of provincial newspapers, were elaborated into something definite, exhaustive, and official. Nothing is gained by the present mode of procedure, as must, indeed, be well known to the experienced people who control the destinies of the Coalite enterprise." The market price of Coalite shares has lately risen considerably. This is a good opportunity for those who were landed with a large number to let them filter out of their hands. There is no need to ask whether the underwriters are aware of the change that has taken place in the value placed by the market on the shares."

Felixstowe's Trouble.

Felixstowe has had a bad experience with the electric light. It has been a perfect nuisance through erratic behaviour. Frequently it has suddenly collapsed, and put a veil of complete darkness over the habitations and other premises of those who had put their trust in it; and the neighbours of the generating station have found it a nuisance through the terrible and soul-disturbing noises that proceeded from it. A Committee of the Council say that these noises have been due to a four-cylinder gas-engine, working on producer gas; the Engineer and Manager of the Company running the works asserts that (it is interesting to notice the confinement of explanation to one instance out of a great number) the noises were caused by one of the Council's own engines, working on town gas, being badly strained by the heavy load on Saturday, Aug. 1. There need, however, be no quarrel over this, as no gas-engine, whether running on producer or town gas ought to bear obloquy for nuisance due to being overwrought. But it is a fact that these troubles have been of long duration; and there are now threats of litigation against the District Council. The Council have done much for Felixstowe. But one of the worst things they ever did for it was when they commenced meddling with electricity; and before they have done with it, they will have found that the pleasures are few of having hanging on to their shoulders an unprofitable business, constantly requiring fresh expenditure upon it. The electricity business is run at present on a sort of dual financial system. The Council find the capital; the Company (who have a 25 years' agreement running with the Council) take the revenue, and hand over 6 per cent. to the Council for sinking fund and interest. The Company, too, have had to bear all the outlay for such things as overhead wiring which did not commend itself to the Board of Trade, and therefore was not paid for by the Council. Now the Council are in this uncomfortable predicament. They have to face litigation owing to the nuisance, or buy out the Company's interest for £8000, on specified terms, and set about putting their house in order by perhaps erecting a new generating station, any way by erecting fresh plant. If advice by their Consulting Engineer is favourable, this is what the Council are going to do. But it all means for Felixstowe a big capital expenditure If the business is not a lucrative one now, what will it be when all this additional expenditure has been incurred? Electric lighting was going to be a fine thing in Felixstowe—according to the electrical prophets. Has it been? The Council are in a good position to-day to answer the question. The Company will be glad to see the end of a bad bargain.

Lord Rosebery and Applied Science.

Lord Rosebery last Wednesday was saying some wise things, and saying them well, at the opening by him of the new engineering laboratories at the world-famed Heriot-Watt College in Edinburgh. Excepting a few stubborn adherents to old fashions and to the slow-moving methods of a past day, most of us are quite agreed that the giving of young men the opportunities for technically and commercially improving themselves, through technical schools, is complying with one of the industrial requirements of the age. In this direction—and naturally—his Lordship's thoughts were bent on this occasion. He urged upon employers the necessity, if they wish to continue to march in the van of industrial progress, to take a leaf out of Germany's book, and to combine with their staffs more technically trained men. There may be a great deal of exaggeration as to what Germany has achieved in consequence of the close and more general union in that country than in this of technical ability and industry; but there is no doubt that the advance made by Germany, and the encroachment effected by it upon the industries of other nations, have been partly due to this leavening of industry and commerce by technical qualification. The advantage, of course, is not all on the side of the employer. The technically trained employee is worth more than one who is not. Education, as Lord Rosebery so admirably puts it, is capital. Technical education increases a man's industrial efficiency, and this is so much added to his material capital. The advantage is therefore mutual. But specialization can be carried too far. His Lordship now suggests the specialization of technical schools and universities, so that each one can be of special service to some particular industry. The advantages of this within the vision of Lord Rosebery is that there would be no overlapping, and an economy of teaching power would result. The great disadvantage we see of such concentration would be the limitation of usefulness. Those whom technical schools and universities specially devoted to training for the industrial and commercial life are intended to benefit have not, as a rule, the means with which to indulge themselves in a long course of technical education without, at the same time and in some manner, exercising their earning power; and where they could, under Lord Rosebery's plan, exercise their earning power might be at a distance from the establishment specially identified with the branch or branches of study applicable to their avocation. Therefore, in large measure, the segregation of scholastic establishments for special branches of technical training would limit the opportunities of men, and would in this way do more mischief than good.

Dessau Vertical Retorts for Sunderland.

THE Dessau vertical retort system is now to be exploited in this country in a definite manner—the Sunderland Gas Company having arranged for an installation of sixty retorts to be erected at their works. Under the arrangement entered into, the work will be carried out by two English firms—viz., Messrs. Samuel Cutler and Sons, of Millwall, and Messrs. Graham, Morton, and Co., of Leeds. The former firm will execute all the structural steel-work, furnace, and retort-fittings, hopper work, and such like in connection with the plant, while Messrs. Graham, Morton, and Co. will undertake the retort-settings, brickwork, and conveying plant.

In our editorial columns for March 24, and in Mr. Hayman's paper read before the Institution of Gas Engineers in June, information was given as to the substantial inroad that the system has already made in the carbonizing operations in Continental Gas-Works; so that the business in this country will start with valuable testimony and practical experience under daily working conditions to which to refer.

GAS STOCK AND SHARE MARKET.

(For Stock and Share List, see p. 809.)

BUSINESS on the Stock Exchange last week in the aggregate was very fairly active for the time of year. Movements were irregular —the tone being bright one day and dull another. But at any rate it was bright at the finish. The chief factor was the persistent cheapness of money; and one leading feature was the unconquerable dulness of Consols, which seemed quite unable to respond to any cheerful influence. Another was that Home Rails had a little more heart in them. The opening on Monday was fairly promising in some leading departments; but the gilt-edged was not among them, and Consols receded. On Tuesday, the position was very much the same; the dull lines remaining depressed. Wednesday was weaker pretty well all round, except in the Gas Market; and Home Rails suffered from disappointment over the reported working agreement. Thursday was another weak day, and prices receded in face of realizations; but Gas issues were strong and active. Things mended again on Friday. The movement to realize abated; and there was moderate recovery in many lines. The improved tone continued on Saturday, and prices generally were higher; but Consols still sulked apart. In the Money Market, the supply was over-abundant, and accommodation could be had at almost nominal rates. Discount rates were weakened by the same influence. Business in the Gas Market was not at high pressure; but prices were firm as a rock. A few weeks ago was pointed out the unaccountably low figures at which some issues were quoted. These inconsistencies have now in a large measure been amended, and one or two of the issues have already changed hands at much enhanced prices. In Gaslight and Coke, the ordinary was moderately dealt in at close prices, ranging from 99¼ to 100. In the secured issues, the preference marked 106½, and the debenture 87. South Metropolitan was quiet and strong, changing hands at from 120½ free to 121½. There was more activity in Commercials; the 4 per cent. being done at from 107 to 109, and the debenture at 83¾. In the Suburban and Provincial group, Alliance and Dublin old was dealt in at 19⅝, Bournemouth "B" at 16¾, British at 42⅜ (a rise of ½), South Suburban at 117½, Tottenham "A" at 136 and 135¼ (an advance of 15 on what it was done at a month ago), ditto "B" at 106½, and West Ham at 101 and 102. The Continental companies were rather quiet, and were firm. Imperial changed hands at from 181 to 182½ (a rise of 1), Union at 108 and 110, and European fully-paid at 23¼ and 23⅜. Among the undertakings of the remoter world, Buenos Ayres was done at 11 7/16, Primitiva at from 5⅞ to 6⅛, ditto preference at 5 13/32 and 5⅜, ditto debenture at 96, and River Plate at from 13½ to 13⅝.

ELECTRICITY SUPPLY MEMORANDA.

Electrical Humour—Tariff Reform—Schemes to Net New Business—Is the Small Consumer worth Angling after?—Wanted, at Hastings, the Application of Private Commercial Ability to a Public Trading Undertaking.

THERE are still many knitted brows among those station engineers who have not given up the occupiers of small-class property as potential customers for their concerns. The trouble is how to get them, and what stands in the way of getting them. Comment on the subject was made a fortnight ago, on a series of articles by Mr. John D. Mackenzie; and now there is again before us quite a batch of literature from other pens dealing with the same problem. Among it is found a series of humorous articles, from the "Electrical Times," on "Cheap House Wiring." The writer, brimming over with jocularity, says that, with metallic filament lamps, candle for candle, the electrical industry can beat the gas mantle, on an overall quarterly account; that gas knows no law, and is not so hide-bound as electricity; and that there ought to be such prohibitive regulations imposed on compo. and chandeliers, that gas would be made so expensive that it could not compete with electricity. There is little use in taking notice of matter presented in the vein running through these articles, as, beyond a transitory tickling of the readers, they have no influence. It is the simplest thing in the world to say that, candle for candle, the metallic filament lamp can beat gas on an overall quarterly account; it is quite another thing to prove it. It is untrue to say that gas knows no law, and is not so hidebound as electricity. The writer of the articles may be referred to Michael and Will on the law relating to gas supply. He will find between the covers of the book many important points on which gas is bound up in a manner that would make electricians go absolutely mad if their supply were similarly treated. As to regulations being imposed on compo. and chandeliers, the compo. can go without a single member of the gas profession turning a hair in anger; and the gas industry do not want the antiquated chandelier, and the sooner the last one is scrapped the better. Their abolition would not make gas-fitting more expensive; as a matter of fact, water-slide chandeliers in their various grades (manufacture of them by the way has been discontinued, and they are not to be found in show-rooms to-day) are more expensive than the simple fittings required for incandescent gas lighting. It is a hard fate—our sympathy is with the electrical industry in the matter—that compels recourse to a mass of extravagant satire and untruth to fill in the skeleton of a case for electricity. From the articles so far as they have yet appeared, it is gathered that the only way in which electricity can compete with the "flaunting libertine gas" is by making electric wiring as cheap as gas-piping; but standing with grim immovability in that way is the prohibition placed on plain or unprotected flexible wiring and the (assumed for the purpose of the case) grandmotherly rules of fire insurance companies. These seem to be the chief obstacles in the mind of the writer of the articles; but those who peep beneath the surface of the superficiality abounding in them, will find the existence of a few other just as awkward obstacles.

Among the other writings before us are two articles on "Tarift Alterations." The question of tariffs is always with students of electricity supply. It has been as restless as the sad sea waves from the very beginning of trading in electricity; and it is now being dashed about with as great vehemence as ever. This persistence of the question, and the remarkable schemes of charges that have been devised, are of the wonders of electricity supply. They point to three things—the difficulty of broadening the base of custom especially for lighting, the costliness of the supply, and the discontent of consumers. Yet is it not written in electrical papers and advertising literature that candle for candle the electricity account is lower than for gas? The metallic filament lamp is the cause of the violence of the fresh outburst anent tariff reform. There are some who would, in consideration of the higher lighting value of the metallic filaments in relation to consumption, put up the price of electricity to users of the new lamps; there are others who would so manipulate the charges, by the adoption of some new system of payment, that the heedless consumer would be deceived as to the total amount he pays. It is the crude and poor measure that the electricians give to all human intelligence but their own that causes new system after system to break down. New conditions, however, sometimes suggest that the resurrection of old systems of charging would not be a bad thing.

Mr. E. E. Hoadley, of Maidstone, thinks this. "For years," he "has devoted himself to the solution of the problem of electric lighting for small houses and shops, with, he is the first to confess, only a limited amount of success; the chief reason being, after the wiring difficulty has been solved, the fact that a gas mantle will light a small sitting-room a good deal better than a 16-candle [electric] lamp." But the salient feature of his article is as to whether the meter is the best rule of charging that can be devised. The electricity meter forms a not inconsiderable item in the fitting up of a house; its maintenance is costly; it requires recalibrating every three or four years; and it is a source of untold annoyance to the central station manager when consumers take it into their heads that their accounts for electricity are more than they ought to be. Mr. Hoadley really believes that the best mode of charging would be a reversion to the primitive system of a fixed lamp and time charge, with the adoption simultaneously of a wiring and fittings supply business on the hire-purchase system. But as soon as electricians begin to talk of such things as price simplification or revision, they also commence to talk of restrictions which are not imposed in connection with gas supply. While Mr. Hoadley would wire living rooms free of initial expense, he would not do so in bedrooms, except on payment of a certain sum per point, as careful records have proved bedroom wiring to be unremunerative. It is one of the characteristics of the electrical industry to want to pick and choose, in a manner that is not practised by the gas industry. In too rigidly studying their own interests, they pay too little heed to the convenience of the consumers. However, for the rooms lighted a fixed charge per lamp would be made, with sealed lamp holders as a check against extravagance—the tenant paying for renewals. Simple as may be the base of a fresh plan of charging proposed by an electrician, he may be depended upon to land himself into complication before he finishes. Mr. Hoadley would charge "so much per annum for shop window lamps, so much per annum for inside lamps, so much per annum for lamps used in dwelling-houses, either striking an average throughout the house, or having different prices for bedroom and sitting-room lamps." The same arrangements as already referred to for lamp renewals and to prevent waste could be arranged for in this case; but "if the consumer signed a small agreement (one clause of which was that he would only use metallic filament lamps), the existing price of these would, Mr. Hoadley thinks, be sufficient to deter him from using his lamps unnecessarily." How long will this condition as to high lamp price continue? It does not strike us as an altogether intelligent proposal to place any reliance on an uncertainty. We do not anticipate any immediate relaxation in the price of metallic filament lamps; but we should be the last to speak of the continuance of present prices as being absolutely positive. The idea also assumes that the lower the number of hours a metallic filament lamp is used, the longer will be its life. Herein is a fallacy, which is best disclosed by saying that, judging from instances in our experience, the fewer the times the condition of a metallic filament is changed from soft to brittle, the longer, generally speaking, will be its life in the number of hours of use. The electrical wags will, of course, say that it should follow from this that, if a metallic filament lamp is run continuously, it should last for ever. Let them say it. It is by continuous running that the long and much-advertised life of metallic filament lamps has been obtained in the laboratory and in certain street lighting experiments—notably at Beckenham.

The transparent simplicity of Mr. Hoadley's plan of charging is its one commendable feature. But this is a commercial age;

and it is an age in which the violation of the eighth commandment is considered by all too many people justifiable when opportunity is forcibly pushed in their path. This is seen in an article by a writer signing himself "Henry Joseph." He tried the experiment of supplying seven 8-candle power lamps per cottage at the fixed charge of 6d. per week in the summer months, 9d. in the autumn and spring months, and 1s. in the winter. The result was most disastrous. It was perfectly astonishing how much current these cottagers used. It worked out to about 30 units per 8-candle power lamp per annum. Of course it did not pay. Henry Joseph has had his experience, and learnt the lesson. He remarks: "It is generally recognized that such small property is best left alone. The income of the tenant does not, as a rule, permit him to pay enough for his supply, however he is charged, to meet the capital outlay on the meters, mains, wiring, services, &c., to say nothing of the generating plant required to supply him." It is the solemn opinion of Henry Joseph that electricians will come back to a flat-rate for all purposes, with a sliding scale for large consumers, and possibly a two-rate meter for consumers whose demand for power or other purposes in the daytime is likely to be sufficient to justify the increased meter-rental.

Those who control the electric light undertaking at Hastings are fearfully sensitive. They shiver at shadows in the most alarming fashion; and in the neurotic disorder from which they suffer, they run into foolish outlay, bring unprofitable financial obligations upon the concern, and then look to the ratepayers, the greater proportion of whom use gas, to help them out of their difficulties. When there is any sign of protest, there is a scampering off to the local newspaper offices, and editorials appear in support of the voracious municipal white elephant and in defence of its keepers. The undertaking has never properly paid its way; and it is one of the most hopeless electricity undertakings of which we have knowledge in a town of the size of Hastings. Its history has been constantly one of deficit; and it has nothing in reserve or for depreciation. Therefore, when bad times hang over it, there is nothing upon which to fall back, and when plant has seen the end of its days, there is nothing for it but to reborrow the money for its replacement. Last year, as the result of the trading of the undertaking, the sum available to meet the financial obligations of the concern was deficient of requirement by about £3000. Mr. Cox at the meeting of the Council the other week suggested that, in consequence of this state of affairs, the price of electricity should be raised by 1d. per unit. It was quite a commonsense proposition, and quite in accord with the principle of the Northumberland clause which Parliament has imposed upon certain electricity undertakings, and which insists that the price of electricity shall be placed at such a figure as is estimated to produce sufficient for all outgoings during the year. That the Hastings Electricity Department could not meet its financial responsibilities last year shows beyond dispute that an insufficient sum was charged for electricity to meet the manufacturing costs, the expenses of management, the establishment charges, as well as sinking fund and interest. Alderman Langham, and Councillors Smith and Bones, however, argued that Mr. Cox's motion, if carried, would be bad business; and they trotted once more into view the old fallacies of the municipal apologist for a bad condition of finance, in an attempt to show it would be a blunder to increase the price of electricity.

What would Messrs. Langham, Smith, and Bones do if this electricity business was their own private concern? Supposing either one of them had borrowed (let us say) £150,000 as capital for the undertaking; and that before one could get a penny piece of profit from it, he had to pay back annually a proportion of the principal, provide the interest on the sum borrowed, the money for the whole of the expenses attaching to the generation of the commodity, the conduct of the business, and the charges coming upon the business in the shape of rates and taxes. Supposing the trading showed time and again a shortage in the revenue required to strike an even line with outgoings, and at length the shortage measured no less than £3000, with, in addition, the business earning nothing with which to replace the plant at the end of its productive life—What, under such conditions, the business being their own, would Messrs. Langham, Smith, and Bones do? Just what they would do privately, if not qualifying for the bankruptcy court or a place where a generous country would take care of them free of charge, is what they should do in the conduct of the municipal concern. We should like them to answer the last question; and from the answer their business capacity could be judged. The electric light undertaking has really only one competitor in Hastings. It is not like the business of a butcher, baker, or draper, where there are several competitors; and why electricity should tremble so before this one competitor, why it should be on such an unstable foundation that, with its loudly proclaimed virtues, 1d. per unit increase in price should rend its business, are points that require explanation, in conjunction with the one as to why gas consumers who do not want electricity should have to contribute to the making good of the under-charges to the electricity consumers. Beyond making these points, we need not waste space on dealing at length with an editorial in the "Weekly Mail," which suggests as serious (seeing that the succeeding sentence commences with the words "more serious still") that "already we have evidence of an impression, hundreds of miles away, that the price of electric lighting in Hastings is likely to be increased." What matters what impression is abroad hundreds of miles away? The Hastings cables do not extend anything like that distance from the town. But we are a bit curious as to what is really meant by the following mysterious passage in the editorial referred to: "There can be no question in the minds of those who have opportunity to make inquiry that the effect of *reducing* the price will be to check an increase, if not positively to reduce the consumption of electric light." The passage is not illuminating.

PERSONAL.

The Liverpool United Gaslight Company have appointed Mr. SAMUEL CARTER Superintendent of the Garston works, in succession to his father, Mr. Richard Carter, who is retiring on a pension. Mr. Richard Carter has been in the service of the Company for nearly forty years. Some twenty years ago he supervised the erection of the Garston works, and on their completion was appointed Superintendent.

At their meeting last week, the Directors of the Preston Gas Company filled up the positions of Engineer and Secretary, unhappily rendered vacant by the death of Mr. Henry Green. They appointed Mr. SAMUEL TAGG Engineer and Manager; and Mr. F. J. NEWBOUND was made Secretary. Mr. Tagg was appointed Assistant-Engineer to the Company about January last, out of over a hundred applicants. He was born at the Radford Gas-Works of the Nottingham Corporation, where his father was Superintendent; and he received his first training at the works. In 1895, he entered the service of the Cheltenham Gas Company as second assistant; and in 1898 he was appointed Works Chemist to the Birkenhead Corporation. A year later he was promoted to the position of Chemist and Draughtsman; and eventually, in 1903, he received the appointment of Assistant-Engineer to the Corporation. Mr. Newbound has been in the employment of the Company for about 25 years.

The number of our contemporary the "American Gaslight Journal" dated the 14th inst., which came to hand yesterday, contains an account of the recent unveiling, in the presence of the officials, of a beautiful tablet marking the completion of the initial two units of the Astoria plant of the Consolidated Gas Company of New York, and the successful operation thereof for a period well over a twelvemonth. The unveiling was preceded by an address by the Active Executive of the Company, Mr. Walter R. Addicks; and it was followed by another equally interesting ceremony. Mr. Down, speaking for the engineers and superintendents directly under the supervision of the Chief Engineer of the Company, Mr. WILLIAM H. BRADLEY, presented him with a handsome silver vase, as a token of appreciation of their connection with him. The illustrations which appear in the "American Gaslight Journal" show that the description of "handsome" is in its very largest sense fully deserved by the vase, which bore the following inscription: "Presented to William H. Bradley, at the Astoria Plant, August 25, 1908, by the engineers, superintendents, and assistants of the Consolidated Gas and its allied Companies, as a token of affectionate regard for their Chief." Aug. 25 was Mr. Bradley's seventieth birthday.

OBITUARY.

The Hornsey Gas Company have sustained a severe loss by the death, on the 14th inst., of Mr. HENRY JAMES MITCHELL, who had for the past thirty-five years occupied the position of Engineer and Manager of the works. Mr. Mitchell, who was 66 years of age, had for a long time been a sufferer from gout, to which his death was attributable.

It is with regret that we receive the news of the death last week of M. ALPHONSE SALANSON, who was, and had been for some years, the President of the Union des Gaz Company in Paris, with which the Continental Union Gas Company, Limited, in London, are so closely identified. M. Salanson was a Past-President of the Société Technique de l'Industrie du Gaz en France, of which he had been a member since 1876. He was a regular attendant at the annual meetings of the Society, and frequently joined in the discussions on the technical papers. He himself contributed many papers on various subjects, and was awarded the Society's prize some half-dozen times between the years 1881 and 1894, after which, being a member of the Council, he was placed *hors concours*. In the earlier period of his gas career, M. Salanson was the Manager of the Nîmes Gas-Works, Gard, France, belonging to the Union des Gaz Company. As a Frenchman born in the City of London, M. Salanson was peculiarly fitted to fulfil the duties that fell to him in later years in connection with the administration of the Anglo-French Company referred to. As far as the limited powers conferred on the French Board of Directors allowed, the late President of the Company was ever ready to deal broadly and generously with all matters and questions that were submitted to him. He was always accessible to the Company's staff, and treated everyone with much courtesy and consideration. His disposition might be summed up in the words genial, just, and generous. The Union des Gaz and Continental Union Gas Companies will certainly be the poorer without his able and level-headed direction of the policies to be pursued in managing their gas affairs in Italy, France, and Germany. M. Salanson was an honorary member of the Institution of Gas Engineers, and in 1907 was elected a member of the Société des Ingénieurs Civils de France.

GAS ACTS FOR 1908.

A COMMENCEMENT is made to-day with our customary review of the Gas Acts of the session. In this, we are omitting all historical references as to the financial or other conditions of the concerns as set forth in the preambles to the Acts. To the extent to which such particulars claim general interest, they are alluded to in the digest of the principal features of the Bills that appeared in the first few numbers of the "JOURNAL" this year. The notices lead off with the Acts of the newly incorporated Companies.

The first Act, following the alphabetical order, is that of the progressive Bognor Gas Company. They have secured the extension they sought to their limits of supply. In connection with this point, new works are to be constructed at Bersted; and the Company are under an obligation to afford a supply of gas to a large portion of the additional area within the next three years. Since the first print of the Bill, there has been a slight modification in regard to the capital; but it is merely nominal in character. It was originally proposed that the capital should be £75,000 consolidated ordinary stock, bearing a standard dividend of 5 per cent. Of this, it was proposed that £39,000 should be the original, and £36,000 the additional capital. In the Act the capital is to be £74,700, of which £17,000 is to be called consolidated ordinary stock "A," and £21,700 consolidated ordinary stock "B;" and the additional £36,000 is to be called consolidated ordinary stock "A." The standard dividend on both classes of stock is 5 per cent., with the sliding-scale operating half yearly. The borrowing powers are to be £12,900 (including £4000 already borrowed by the limited Company) in respect of the original capital existing at the passing of the Act, and £12,000 in respect of the additional capital. We here come across for the first time the new special purposes fund clause, which is the creation of the parliamentary authorities in lieu of the insurance and renewals funds. The text of the new clause was given in the "JOURNAL" for May 19, p. 421, in which number certain features of the clause were criticized. A reserve fund is provided for. The balance of revenue allotted to be carried forward is not to exceed an amount equal to a year's dividend. The new and less stringent auction clauses are incorporated in the Bill, in accordance with the model form reproduced in our issue for March 17 (p. 711). The only difference is in the extension of section 3 by this proviso: "Provided, in the case of an offer to holders of shares or stock, that, if the aggregate amount of stock applied for shall exceed the aggregate amount so offered as aforesaid, the same shall be allotted to, and distributed amongst, the applicants, as nearly as may be, in proportion to the amounts applied for by them respectively." The standard price of gas is to be 4s. 1d. in Bognor, Felpham, and Bersted. In the Bill 4s. 3d. was named for the other outside parishes; but in the Act we see that the price to be charged in the parishes of Aldingbourne, Eastergate, Barnham, and Yapton is, for a period of five years from the passing of the Act, to be not less than 6d. nor more than 8d. per 1000 cubic feet in excess of the price for the time being charged in Bognor; and after the expiration of five years, the price is to be 6d. per 1000 cubic feet in excess of the charge in Bognor; while the price in Pagham is to be the same as in the parishes just named, except in a small specified area, in which the price is to be only 3d. in excess of that in Bognor. The price for public lighting is not to be more than 3s. 11d. in Bognor, Felpham, and Bersted, and 4s. 1d. in the other parishes. The standard illuminating power has gone up 1 candle (to 15 candles) since the Bill was deposited; but, in place of the proposal in the latter to use the old No. 1 "London" argand burner for testing, the "Metropolitan" No. 2 burner is to be used. The old discount clause, imposing a limit of 10 per cent. for prompt payment, and 15 per cent. for large consumption, continues in the Act, instead of advantage being taken of the liberty that the modern model clauses permit in this respect. A number of protective clauses for various bodies appear; but there is nothing specially noticeable about them. [*Parliamentary Agents: Messrs. W. & W. M. Bell.*]

The Central Ireland Electric Power Act reminds of the extraordinary means by which it—true in very much curtailed form—was revived after being rejected by a Committee of the House of Commons, on the ground that there was not any sound financial case in support. In other words, the whole scheme was deemed to be too speculative. Peat, it will be remembered, is to be employed in this scheme for the production of gas, and the gas is to be used for the generation of electricity for distribution for sale in bulk and for power. The area of supply is to be the County of Dublin (except the municipal area of the city of Dublin, the urban districts of Rathmines and Rathgar and Pembroke, and the baronies of Balrothery, East Balrothery, West and Nethercross), the county of Kildare (except the baronies of South Naas, Kilcullen, Naaragh, and Reban East and Kilken and Moone), and so much of Queen's County as is comprised in the baronies of Portnahinch and Maryborough East, and the barony of Stradbally other than that portion included in Tullomoy parish. The capital has been reduced from £450,000 to £150,000, with one-third borrowing powers. The sum of £25,000 of capital is the minimum upon which the compulsory powers may be put into force. A batch of protective clauses appear in favour of various authorities, among them the Alliance and Dublin Consumers' Gas Company, in respect of their distributing system. [*Parliamentary Agents: Messrs. Torr and Co.*]

The East Metropolitan Power Supply Bill (the promotion of the British Coalite Company) was dropped early in its career, as was also the Greystones Gas Bill.

There were some material changes made in the Swinton and Mexborough Gas Company's measure during its passage through Parliament. At the very beginning of the Act, it is found that section 13 of the Gas-Works Clauses Act, 1847, has been extended by the sensible addition now permitted by the model clauses which obviates the prescription of limitations to discounts. In the Bill as originally drafted, 25 per cent. was prescribed for prompt payment, and to large consumers "upon such scale, and subject to such conditions and regulations as may be prescribed by special contract, in writing, between the Company and any such consumers, provided," &c. That is much the same thing as the extension allowed of section 13 of the 1847 Act; but the latter is simpler and much more concise. The limits of the Company are defined as the township of Swinton in the parish of Wath-upon-Dearne and the parishes of Mexborough and Aldwick-upon-Dearne. The capital proposed in the Bill for the newly incorporated Company was £59,500. Of this, £15,000 was cleared away during the proceedings in Parliament, leaving the capital at £44,500, of which £19,500 is the original capital, and £25,000 the additional. The original capital is to be divided into 1900 "A" shares and 2000 "B" shares. There was in the Bill a proviso to the capital clause to the effect that nothing in the Act should render the Company liable to deliver a statement, or pay stamp duty under section 113 of the Stamp Act, 1891, as extended by section 12 of the Finance Act, 1896, in respect of the original capital. Apparently Parliament had an eye to the protection of the Inland Revenue Commissioners, as this proviso appears to have been deleted. The dividend is to be 10 and 7 per cent. on the respective classes of capital, and 5 per cent. on preference issues (6 per cent. was specified in the Bill). In any year in which the funds applicable to dividend on the ordinary capital are insufficient to pay the full amount of dividend at the authorized rate on each class of ordinary shares in the capital, "such funds shall for that year be applicable in the first place to the payment, so far as the same will extend, of dividends up to the rate of 7 per cent. per annum upon the whole amount for the time being credited as paid-up on the ordinary capital of whatever class, and the surplus (if any) shall be applicable to the payment of a further dividend on the 'A' shares." A reserve fund is provided for; and the new general purposes fund appears. The revenue carry-forward is limited to the equivalent of a year's dividend at the authorized rates. In the Bill it was intended that new issues of capital should be offered to the consumers and employees before being put up to auction or offered by tender to the public; but in the Act the revised auction clauses appear. The borrowing powers are to be (inclusive of £6000 borrowed by the limited Company) the usual one-third part of the amount of issued capital. In the Bill the standard price of gas was proposed at 5s.; in the Act it is 3s. 6d., with the sliding-scale operating annually. The ordinary prepayment meter clause is varied in the Act. After providing for the 10d. excess for meter and fittings and 1s. for meter and fittings including cooking-stove, there are these changes: "The maximum charge for the hire of a prepayment meter without fittings shall be at the rate of 8d. per 1000 cubic feet of gas supplied through such meter. The Company shall be entitled, if they think fit, to require a deposit of 1s. per quarter for a prepayment meter, provided that the amount collected from the prepayment meter during such quarter shall be applied in the first place in refunding the said deposit to the person who has paid the same." The standard illuminating power of the gas is placed at 14 candles, tested by the "Metropolitan" No. 2 burner; and the Harcourt 10-candle pentane lamp. A purchase clause, operative next session, in favour of the District Councils of Swinton and Mexborough appears in the Act.

By the Southwell District Gas Act, the old Limited Company has been incorporated, and given extended limits of supply in the county of Nottingham. The capital is to be £36,500, of which £16,500 is original capital and £20,000 additional; the preference issue not to exceed one-half of the latter amount. The borrowing powers are fixed at the usual one-third. The new auction clauses are applied to future stock issues. Dividends are limited to 5 per cent. on the preference stock, 10 per cent. on the original ordinary stock, and 7 per cent. on the additional capital. The new special purposes fund clause appears in place of the insurance and renewals funds. A reserve fund clause is incorporated. The standard price of gas has receded from 4s. 2d. to 3s. 10d., with an annual operation of the sliding-scale. The quality of the gas is to be 14 candles, using the "Metropolitan" No. 2 burner and the Harcourt 10-candle pentane lamp. The enabling power to apply for an Electric Lighting Order has been removed. [*Parliamentary Agents: Messrs. Crowders, Vizard, Oldham, and Co.*]

What was known as the Swansea Valley Gas Bill now appears before us as the Tawe Valley Gas Act. The new Company are taking as the nucleus of their undertaking the Ystalyfera and the Pontardawe Gas-Works; and a district is mapped out for them which to describe occupies rather more than a page of the Act. The capital has been reduced from £50,000 to £30,000, with one-third (one-fourth was mentioned in the Bill) borrowing powers. Power to create a reserve fund is granted; and the new auction clauses are included. The standard price in the Bill was 5s. It is now to be, for a period of two years from the passing of the Act, 4s. 9d. per 1000 cubic feet, and thereafter 4s. 6d. The sliding-scale is to operate half yearly—the standard dividends

being 10 and 7 per cent. The model prepayment clauses are included. The prescribed illuminating power has been altered from 12 to 14 candles, tested on modern lines. Insurance and renewals funds appeared in the Bill; they are absent in the Act, and the general purposes fund clause has not taken their place. [*Parliamentary Agents: Messrs. W. & W. M. Bell.*]

THE "MODEL BILL"—LATEST AMENDMENTS.

THE "Model Bill," as amended by the House of Lords for the ensuing session, is just to hand. It contains several alterations which will be of interest to gas and water companies possessing, or intending to possess, parliamentary powers.

We notice, in the first place, that the restriction hitherto contained in the power to raise additional capital, that "no share or stock shall vest in the person or corporation accepting the same unless and until the full price of such share or stock, including any premium obtained upon the sale thereof, shall have been paid in respect thereof," has now been eliminated.

The clause as to the application of money, which appeared in some former editions of the "Model Bill," has been re-introduced in the following modified form:

All moneys raised under this Act including premiums shall be applied only to purposes to which capital is properly applicable, and any sum of money which may arise by way of premium from the issue of shares or stock under the provisions of this Act shall not be considered as part of the capital of the undertakers* (*sic*) entitled to dividend.

The new clause giving power to create a Special Purposes Fund, which has already been set out and criticized in our columns [see also below], has been substituted for the previous clauses relating to insurance and renewal funds. We notice, however, that a new sub-clause has now been added, which provides that the money or securities standing to the credit of the insurance fund at the passing of the Act shall be credited to the Special Purposes Fund, and that the section of the former Act relating to the insurance fund shall be repealed.

The clause dealing with the application of excess of profits over authorized rates of dividend has been amended by the addition of a proviso that the sum so carried forward shall not in any case exceed the amount required to pay one year's dividend at the authorized rate.

The Bill also contains the new form of auction clause to which reference has already been made in the "JOURNAL"—see also below.

The clause, "Company may Acquire Easements only in Certain Cases," which has been in use for many years, is now added to the water portion of the Bill.

A new and important clause has also been inserted, which will be applicable in all cases where land powers of a compulsory nature are applied for. It runs as follows:

The tribunal to whom any question of disputed purchase money or compensation under the Act is referred, shall if so required by the company award and declare whether a statement in writing of the amount of compensation claimed has been delivered to the company by the claimant giving sufficient particulars and in sufficient time to enable the company to make a proper offer and if the tribunal shall be of opinion that no such statement giving sufficient particulars and in sufficient time shall have been delivered and that the company has been prejudiced thereby the tribunal shall have power to decide whether the claimant's costs or any part thereof shall be borne by the claimant. Provided that it shall be lawful for any judge of the High Court to permit any claimant after seven days' notice to the company to amend the statement in writing of the claim delivered by him to the company in case of discovery of any error or mistake therein or for any other reasonable cause such error mistake or cause to be established to the satisfaction of the judge after hearing the company if they object to the amendment and such amendment shall be subject to such terms enabling the company to investigate the amended claim and to make an offer *de novo* and as to postponing the hearing of the claim and as to the costs of the inquiry and otherwise as to such judge may seem just and proper under all the circumstances of the case. Provided also that this section shall be applicable only in cases where the notice to treat under the Lands Clauses Consolidation Act 1845 either contained or was endorsed with a notice of the effect of this section.

To clearly show some of the alterations above referred to, it will be well to quote *in extenso*, from the Model Bill, one or two of the clauses as finally adjusted. The first of these to be noticed is the clause that has been substituted for previous clauses relating to insurance and renewal funds. It is as follows:

Power to Create a Special Purposes Fund.

12.—(1) The directors of the company may if they think fit in any year appropriate out of the revenue of the company as part of the expenditure on revenue account any sum not exceeding an amount equal to 1 per cent. of the paid-up capital of the company including premiums to a fund to be called the "Special Purposes Fund."

(2) The Special Purposes Fund shall be applicable only to meet such charges as a chartered accountant or incorporated accountant being the auditor of the company or appointed for the purpose by the Board of Trade shall approve as being—

(*a*) expenses incurred by reason of accidents strikes or circumstances which due care and management could not have prevented, or

(*b*) expenses incurred in the replacement or removal of plant or works other than expenses requisite for maintenance and renewal of plant and works.

(3) The maximum amount standing to the credit of the Special Purposes Fund shall not at any time exceed an amount equal to one-tenth part of the paid-up capital of the company including premiums.

(4) The moneys forming the Special Purposes Fund or any portion thereof may be invested in securities in which trustees are authorized by law to invest or may be applied for the general purposes of the company to which capital is properly applicable, or may be used partly in one way or partly in the other.

(5) Resort may from time to time be had to the Special Purposes Fund notwithstanding that the sum standing to the credit of the fund is for the time being less than the maximum allowed by this section.

(6) [The money or securities standing to the credit of the insurance fund of the company at the passing of this Act shall be credited to the Special Purposes Fund and section of the Act of is hereby repealed.]

It may also be convenient to quote the auction clause as adopted in Bills of 1908. It runs—

New Shares or Stock to be Sold by Auction or Tender.

15.—(1) All shares or stock created under the powers of this Act shall be issued in accordance with the provisions of this section.

(2) All shares or stock so to be issued shall be offered for sale by public auction or tender in such manner, at such times, and subject to such conditions of sale as the company shall from time to time determine. Provided as follows:

(*a*) Notice of the intended sale shall be given in writing to the Town Clerk of and to the Secretary of the London Stock Exchange at least twenty-eight days before the day of auction or the last day for the reception of tenders as the case may be, and shall also be duly advertised once in each of two consecutive weeks in one or more local newspapers circulating within the said borough:

(*b*) A reserve price shall be fixed and notice thereof shall be sent by the company in a sealed letter to be received by the Board of Trade not less than twenty-four hours before, but not to be opened till after, the day of auction or last day for the receipt of tenders as the case may be:

(*c*) No lot offered for sale shall comprise shares or stock of greater nominal value than one hundred pounds:

(*d*) In the case of a sale by tender, no preference shall be given to one of two or more persons tendering the same sum; in the case of a sale by auction a bid shall not be recognized unless it is in advance of the last preceding bid:

(*e*) It shall be one of the conditions of sale that the total sum payable by the purchaser shall be paid to the company within three months after the date of the auction or of the acceptance of the tender as the case may be.

(3) Any shares or stock which have been so offered for sale and are not sold may be offered at the reserve price to the holders of ordinary [* and preference] shares or stock of the company in accordance with the provisions of sections 18, 19, and 20 of the Companies Clauses Act, 1863, and to the employees of the company, and to the consumers of gas supplied by the company, in such proportions as the company may think fit or to one or more of these classes of persons only: Provided, in the case of an offer to holders of shares or stock, that if the aggregate amount of shares or stock applied for shall exceed the aggregate amount so offered as aforesaid, the same shall be allotted to and distributed amongst the applicants as nearly as may be in proportion to the amounts applied for by them respectively.

(4) Any shares or stock which have been offered for sale in accordance with sub-section (2) or with sub-sections (2) and (3) and are not sold, shall be again offered for sale by public auction or by tender in accordance with the provisions of this section, and any such shares or stock then remaining unsold may be otherwise disposed of at such price and in such manner as the directors may determine for the purpose of realizing the best price obtainable.

(5) As soon as possible after the conclusion of the sale or sales, the company shall send a report thereof to the Board of Trade, stating the total amount of the [* respective] shares or stock sold, the total amount obtained as premium (if any), and the highest and lowest prices obtained for the [* respective] shares or stock.

* Omit words in brackets where there are no preference shares or stock.

* The word "undertakers" is obviously a misprint for "company."

Cleaning Water-Mains.—The cleaning of water-mains in order to increase their capacity has begun to attract attention generally in America, after remaining in abeyance for nearly twenty years; the experience at that time not being sufficiently satisfactory to lead to its continuation. It was stated that the cleaning-machines caused trouble by destroying cocks projecting through the shells of the pipes, and that a main once cleaned became clogged very rapidly by tubercles. According to "Engineering Record," this opinion has been quite recently somewhat changed as a result of the work done by companies who give special attention to it. Two years ago, an important paper on the subject was read before the American Water-Works Association by Mr. N. S. Hill, jun. Since that time the managers of certain water-works have been paying more attenion to the possibility of increasing the capacity of their old mains by cleaning them; thus putting off the date when larger or additional pipes must be laid. The results of recent American experience indicate that where the demand for water is close to the capacity of the mains, and the latter are clogged to any extent, it is economical to have them cleaned. It is always necessary to remember that, under usual conditions, the test of the efficiency of a system of water-works is not the delivery of enough water to meet the needs of regular consumers, but the extraordinary demand that arises when a serious fire breaks out.

GAS-ENGINE FAILURES.

(*Concluded from p. 710.*)

In the account of failures there is instruction as to what to avoid to attain greater success; and therefore no excuse is required for dipping a little deeper into the report of Mr. Michael Longridge for illustration of the causes of the breakdown of gas-engines during 1907. Each instance selected contains a lesson.

Take the statement of an accident to a horizontal gas-engine, six years old, with cylinder 16 inches diameter by 23-inch stroke, running at 160 revolutions per minute. The cylinder was connected to the target end of the bed-plate by six studs $1\frac{3}{4}$ inches diameter, screwed into the latter and passing through six lugs cast upon the front end of the cylinder jacket at equal distances round its circumference, and by nuts behind the lugs. These lugs were not faced across to bed upon the target end, but were set back from the faced surface of the jacket, so that there was a space of $\frac{1}{8}$ inch between them and the face of the target end. Thus by tightening the bolts the lugs were submitted to a bending and shearing stress, which, in the case of one of them, seems to have been high enough to start a crack. The studs were screwed five threads per inch; so that for every inch of length of key used for tightening the nut, the load upon the bolt was 31 times the pull upon the end of the key. The ordinary spanner for a $1\frac{3}{4}$-inch nut would be about 24 inches long, so that the very moderate two-handed pull of 100 lbs. exerted 4 inches from the end of the spanner would put a load of 62,000 lbs. upon the bolt. If the leverage were increased by sticking a piece of pipe on to the end of the spanner, or the force intensified by striking it with a sledge hammer, the load on the bolt and the strain on the casting could easily be increased beyond the resistance of the cast iron. As the nuts had been tightened since the engine was erected at the works, on account of the cylinder springing, it is probable that the crack was started in this way, and had gradually extended until it was discovered by the attendant when cleaning the engine.

There is, too, the case of a horizontal gas-engine, six years old, running at 250 revolutions per minute, with town gas. The cylinder was $4\frac{1}{8}$ inches diameter by $7\frac{1}{2}$ inches stroke. The connecting-rod big end was of the marine type, with two bolts $\frac{1}{2}$ inch diameter reduced to $\frac{7}{16}$ inch in the middle of the shank. As the crank pin began to knock, the brasses were taken off and stripped. When put back, the knocking was worse than before; and it suddenly became so bad that the attendant stopped the engine to see what was the matter. He found the upper of the two big end bolts broken through the bottom of the thread next the shank, and the other bent. The inspector who examined the engine after the breakage found that the screw-thread had not been continued far enough down the shank to allow the brasses to be tightened after, and possibly even before, they had been stripped. The long-continued succession of blows upon the bolts while the engine was running with slack brasses, culminating in still heavier blows after the brasses had been stripped, had probably started and completed the fracture. The stress on the bolts due to the inertia of the moving parts was about 500 lbs., or about 2050 lbs. per square inch of sectional area.

A fly-wheel mishap deserves extended consideration. The gas-engine was a horizontal one, thirteen months old, driving machine-tools with gas from the town main. The cylinder of the engine was 10 inches in diameter; the stroke of the piston, 18 inches; and the speed, 170 revolutions a minute. The engine had two fly-wheels, each 5 ft. 3 in. diameter, cast solid, with six curved arms and boss 9 inches diameter without hoops. The centre of one wheel was $17\frac{1}{2}$ inches from the right-hand end of the shaft, and the centre of the other $35\frac{1}{4}$ inches from the left-hand end, which also carried the driving-pulley. The shaft was $4\frac{1}{4}$ inches diameter without swells for the wheels, which were secured each by a single sunk key. The fly-wheel on the left-hand end of the shaft collapsed suddenly while the engine was driving its usual load. The boss was split through the keyway; all the arms were snapped off near the rim; and five of them near the boss as well. The rim was not broken, neither did it bend the shaft, tear the latter out of its bearings, or break the belt-pulley. On the contrary, it somehow mounted upon the rim of the latter, and wedged itself fast upon it. The cause of the breakdown was an ill-fitting key. An examination of the parts after the breakdown showed that the upper surface of the key was polished by rubbing and the edges bruised, while the lower surface had only been in contact with the shaft at the edges. The sides of the key were also rubbed bright and slightly indented by the edges of the key-way in the shaft, which were themselves slightly burred by the pressure of the key. The internal surface of the boss of the wheel, including the key-way, was battered and polished by rubbing, as also was the surface of the shaft which had been in contact with it. Apparently the key had originally fitted hard against the sides of the key-way in the shaft, and more lightly against the bed of the key-way in the boss. The boss had not fitted the shaft; and the surfaces of the shaft rubbing against the sides of the key had been too small to bear the pressure without deformation and wear. The key thus loosened allowed the wheel to rock and split the boss from one corner of the key-way.

The case is mentioned because it is typical; and Mr. Longridge thinks that the numerous cases of which it is a type suggest that the ordinary system of casting the fly-wheels of gas-engines with solid bosses, and securing them with one or two sunk keys, might advantageously be changed. There are two objections to it. First, that if the shafts are made parallel, as they usually are except for large engines, and if they are long enough to carry a driving-pulley outside the fly-wheel, there is difficulty in forcing a tightly fitting wheel home, especially if the wheel has to be put on after the engine has been erected at the purchaser's works. The other difficulty is in sinking the key-bed deep enough without unduly weakening the shaft, and in fitting the key accurately to it. The only way to make a sunk key of the ordinary dimensions effective would be to make it fit top, bottom, and both sides in a wheel and shaft tightly fitting each other. Then there would be no room for any deformation from plastic-flow of the materials; and the key would probably keep tight. But such fitting is a practical impossibility. The fitter must choose between the top and bottom surfaces of the key on the one hand and the side of the key on the other. In the first case the key is too narrow; in the second, the bearing surface, particularly upon the shaft, is too small. If it be intended to hold the wheel by radial pressure, would it not be better to hang it on broad keys fitted upon flats upon the shaft, but if by tangential pressure to secure it by keys fitted as shown in figs. 1 and 2? The objection to such keys is that the key-ways weaken the shaft, and that the pressure of the key upon the edge of a key-way in a steel shaft will have a tendency to start a crack as indicated in the figure. The better plan seems to be to split the boss of the wheel, bore it slightly smaller than the diameter of the shaft, wedge the two halves apart, slip the wheel on to the shaft, withdraw the wedge, and secure by two or four strong bolts, dispensing with keys altogether. If this method be adopted, the part of the shaft gripped by the boss should be of slightly larger diameter than the part just outside it, as indicated by figs. 3 or 4, so that the edges of the boss may not indent the skin of the shaft and start a crack.

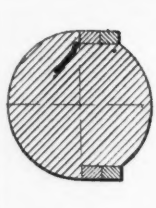


Fig. 1.

Fig. 2.

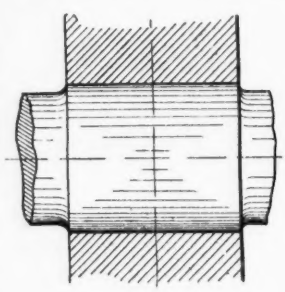


Fig. 3.

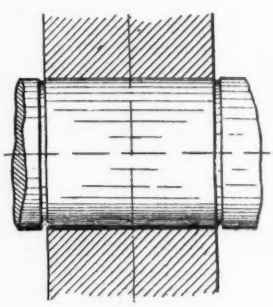


Fig. 4.

The details of an explosion suggest reflection. The gas-engine was a horizontal one seven years old, working with town gas. The cylinder was 8 inches diameter by 16-inch stroke; and the speed 185 revolutions per minute. The engine, after running for three hours on the day of the accident, was stopped for about an hour. On starting again, a violent explosion occurred, shattering the frame and tearing the pieces away from the holding-down bolts and cylinder. The pieces were blown about the engine-room; and the cylinder, crank-shaft, and fly-wheel were displaced. The explosion was caused by the ignition of a mixture of gas and air inside the bed-plate through which the air for the cylinder charge was drawn. As usual in these cases, the presence of the explosive mixture inside the frame was not accounted for. It was suggested that the engine had perhaps stopped with the crank in such a position that the gas and air valves were open, and that during the stoppage some one walking past the engine had inadvertently opened the stop-cock on the gas-supply pipe, and thus allowed the gas to escape into the cylinder and through the open air-valve into the frame. But is it really necessary to make these assumptions? Would not the same effect be produced if the driver, after opening the gas-cock to start the engine, took rather more time than usual in pulling round the fly-wheel to make the charging stroke? In such a case, it is quite possible that with gas under pressure, a volume greater than the piston displacement would pass the gas-cock during the suction-stroke, and that the surplus would flow through the open air-valve into the frame. Having once filled the supply-pipe and frame with an explosive mixture, an explosion almost necessarily follows. If the air-valve be leaking, it will occur on the ignition of the charge in the cylinder. If the valve be tight, it will probably occur at the next opening of the air-valve, for the first charge being too rich, and very slightly compressed, will probably burn so slowly that flame will linger in the cylinder throughout the exhaust stroke, and ignite the incoming charge and the mixture in the frame. If the air for the cylinder be drawn through the frame, the latter should have large openings in the sides to act as safety-valves in case of an explosion. It is better to draw the air through a separate box and filter with a light cover, so placed that no damage will be done if it be blown off.

Explosions of gas-making plants continue to occur, generally through want of understanding on the part of the attendant, but sometimes through faulty arrangement of the apparatus. The following is a fair example of such cases. The plant which exploded was a suction-gas plant for supplying a horizontal engine, with cylinder 14 inches diameter by 22-inch stroke, running at 164 revolutions per minute. It consisted of the usual generator, scrubber, and expansion box. The fan for blowing-up the fire at starting was placed between the generator and the scrubber; and between it and the scrubber was a three-way cock, by which the generator could be put into communication with the chimney, the scrubber, or with both simultaneously. The plug of the cock could be turned into any position. At the bottom of the chimney was a test-cock. Between the scrubber and the engine, there was a second chimney or escape-pipe, with a stop-cock. The scrubber top was blown off when preparing to start the engine.

Two accounts of the accident were given to the Company's inspector by the attendant—the first a few hours after its occurrence; the second some days later, after the latter had had time to study the printed instructions issued by the makers of the plant, and to consider how far he had obeyed them. These instructions were: First, to put the generator in communication with the chimney by setting the three-way cock to the specified position, and blow up the fire till the gas would burn freely at the test-cock. Secondly, when the gas burnt freely at the test-cock, to put the generator in communication with the scrubber by turning the three-way cock to the position described, then to open the cock on the escape-pipe, and continue blowing to clear the scrubber and expansion box of foul gas or air, and fill it with pure gas fit for use in the cylinder of the engine. Thirdly, to shut the cock on the escape-pipe, and start the engine. What the attendant actually did, according to his first account, was this: He put the generator in connection with the chimney, blew up the fire, opened the stop-cock on the escape-pipe, and lighted the gas at the mouth of the escape-pipe. He then "partly closed" the three-way cock, opened the test-cock, and applied a light to it, when the explosion followed. In his second account, the attendant said he followed the instructions up to the opening of the stop-cock on the escape-pipe, and then departed from them by lighting the gas at the mouth of the escape-pipe, when the gas in the pipe and scrubber exploded.

The first explanation is probably the more correct; and having regard to the design of the three-way cock, it is easy to see how the explosion was brought about. The probability is that, when the stop-cock on the escape-pipe was opened, the scrubber, expansion-box, and pipes were full of pure gas left in them when the engine stopped the previous afternoon, which would not burn until it reached the air at the mouth of the escape-pipe. It is also probable that, when the fan was started, the three-way cock was open to the scrubber as well as to the generator; so that, as soon as the stop-cock on the escape-pipe was opened, an explosive mixture of air and gas, or foul gas, was forced into the scrubber to take the place of the pure gas burning at the mouth of the escape-pipe, and that, after being partly closed, it still allowed communication between the three. Under such circumstances, it is evident that a light applied to the test-cock would ignite and explode the mixture. If the second explanation be the true one, it is almost necessary to assume that the scrubber and expansion-box had in some way become charged with an explosive mixture or with air during the previous night. In the first case, an explosion would follow the ignition of the mixture at the mouth of the escape-pipe; in the second a moment would arrive when the pure gas, being blown into the scrubber, would be mixed with the air contained therein in such proportions as to explode when brought in contact with a light. Either condition might no doubt have been produced by leaving the stop-cock open or the scrubber in communication with the atmosphere through the three-way cock and with an insufficient water seal. Only in either case one would have expected the expansion-box rather than the scrubber to have suffered.

By appropriate manipulation of the cocks, with suitable mixtures of gas and air in the scrubber and expansion-box, an inexperienced person, like the attendant in this case (who had only been in charge of the plant three days), could doubtless produce explosions in this or other ways. But Mr. Longridge is inclined to think that the account first given was substantially correct, and that if the three-way cock had been so constructed that it could not be opened simultaneously to the scrubber and to the atmosphere, it would have been much more difficult to have blown up the plant. But even with a properly arranged three-way cock between the generator and the scrubber, there will always be a risk in testing the gas in the escape-pipe, unless the scrubber, expansion-box, and pipes contain nothing but pure gas when the test is made. To minimize the risk of explosion by testing at this critical period, the test-cock, as well as that on the escape-pipe, should be fitted with wire-gauze flame-arresters.

In the exhibition which is to be held in connection with the forthcoming International Road Congress, the Roads Improvement Association are arranging to show a number of samples of road materials, &c., in the space that has been placed at their disposal by the Ligue Contre La Poussière des Routes. The samples will consist of road tar treated and made with various dustless materials, and will include sections of road immediately after treatment, and sections cut after a certain period of wear.

DAYLIGHT AS A STANDARD OF LIGHT.

In the development of artificial illuminants, increasing attention has been paid within recent years to the requirements, or supposed requirements, of the human eye. The question of the degree of brightness which the eye can or ought to stand has been borne in mind by the more thoughtful students of artificial lighting, and they have from time to time spoken of the possible danger arising from excessive or concentrated light. Apart from such warnings, however, physical discomfort experienced by the eye has of itself forced the attention of lighting engineers where lamps have high intrinsic values, and globe obscuration and concealed illumination methods have frequently been the result.

Investigation is now to some extent bringing other points to the front for discussion, and we find stress being laid upon the further advisability of considering that quality or character of artificial light sources which depends upon varying proportions of colour-waves. The wave analysis of light sources has been at different times undertaken by several investigators; but the results so far obtained have not been seriously considered—indeed have been ignored—by the great majority of practical lighting experts. The chief work done in this respect has probably been undertaken on the Continent, where the colour values of daylight and artificial illuminants have been examined and contrasted. We have in mind for the moment the work of Dr. W. Voege, of the Hamburg Government Physical Laboratory, who, by means of different coloured glass, used in cutting out parts of the spectrum, was enabled to photometrically measure the rest in the ordinary way. More recently and probably much more thoroughly, investigation of the same subject has been carried out by Dr. E. L. Nichols of Cornell University, U.S.A. This gentleman has undoubtedly earned the thanks of all who are interested in what may be termed lighting physics for the valuable data and information which he has just given to the world through the medium of a contribution made to the Illuminating Engineering Society. The work, undertaken during six months' visit to the Continent, covers an investigation of the intensity and the quality of daylight, and includes a comparison of the colour values of average diffused daylight with those of the chief artificial illuminants. The chief features of the paper will be found on other pages of this issue (pp. 790-2).

Dr. Nichols had first of all to make many observations, under different conditions, in order to obtain data for striking an average of the physical factors which go to make diffused daylight. Daylight is a very variable quantity; and the extremes in natural illumination to which the human eye is subjected from time to time suggest the range of its adaptability. Professor Basquin in his investigation of the subject (see "Journal," Vol. XCVIII., p. 742) showed that considerable differences occur according to the place, the season, the time of day, the nature of the sky, and the reflective nature of the earth's surface. Dr. Nichols not only quotes but substantially corroborates the professor's data. Basquin (following Weber) had shown a variation in bright daylight of nearly 10 to 1 as between July and December, and an average diurnal difference of $3\frac{1}{2}$ to 1 as between the hours 7.30 a.m. and 4.30 p.m. There is here sufficient variation to indicate how far the eye is accustomed, and can adapt itself, to changes of light intensity. Such a range can well deal with the differences due to mere atmospheric changes, although that between very bright sunlight and a dull overcast sky is great.

Notwithstanding this adaptability, daylight in its brightest form represents nearly the upper limit of intensity at which the eye can work without fatigue and injury. Dr. Nichols looks upon diffused daylight as being the normal stimulus of the eye; and accordingly he considers that artificial stimuli should not depart widely from it as a standard of intensity or quality. With this, we are not altogether prepared to disagree. It is probably the safest illumination for ordinary purposes. But there are times and occasions when a modified form of even diffused daylight is not unwelcome—as, for instance, during the continuous work of an indoor business day. It is probably in the occupations of writing, reading, and the like, that the adventitious aid of reflected light from paper increases the effect of the normal illumination; and for tired eyes a subdued light helps to lessen fatigue. The eye has, as Dr. Nichols suggests, been developed under, and is adapted to, daylight as its natural stimulus; but relatively it was under the conditions of a much shorter day, and with work requiring less close and concentrated vision than at present. It does not, therefore, follow that because daylight is the normal stimulus, a prolonged period of the same light, brought about by artificial illuminants approximating thereto in effect, is physiologically wise for the eye.

By way of analogy, it may be said that the limbs of the body require exercise; bnt no one would suggest that, if in their development it is necessary to prolong that exercise, it should be done without change in its character. There is, indeed, the possibility that the eye, not being evolved under conditions of continuous use and close work, such as modern life necessitates, would be helped by a variation in the nature of the illumination to which it is subjected after daylight has gone. In other words, it may be preferable in the development of artificial light sources not so much to reproduce the intensity and quality of natural light as to eliminate or reduce those factors which in bright daylight admittedly tend to be exacting and trying to the eye.

Dr. Nichols remarks that primary man was not nocturnal in

his habits; and it may be said, therefore, that night must have some purpose—in affording a rest to the eye as well as the body. Artificial illumination is a necessary evil, speaking physiologically, and the best we can do is to minimize the effects of the evil. It is generally accepted that violet and blue rays approximate to the ultra-violet in their injurious influence. Daylight, taken as the illumination of a shaded surface, is relatively strong in blue rays—stronger than most of the artificial illuminants to which man has become accustomed; and it becomes, therefore, problematical whether anything is gained by designing light sources on strictly daylight lines. The suggestion possibly may not, on investigation, be borne out by the facts; but, on the other hand, there is not sufficient evidence yet to show that diffuse or any other form of daylight is, in all its qualities, such as to be established as the best standard for all illumination purposes.

It is not, of course, forgotten that our conception of colours has been derived from daylight study, and that for the like appreciation of colour-effects at night similar illumination is desirable. For general use, however, artificial lighting is not so much concerned with the comparison and matching of tints; the greater question of the avoidance of possible ocular fatigue stands first. However, diffuse daylight has been accepted by many as the criterion of excellence for artificial illumination; and light sources are frequently judged by their approximation thereto. Dr. Nichol's comparisons are made with this as the standard; and, pending definite knowledge, it is probably the best and safest for the purpose.

Turning now to the colour values of average diffused daylight as deduced by the author, it is interesting to compare them with those arrived at by Dr. Voege, to whose work allusion has already been made. Both investigators reduce their results to a basis of equal brightness in the yellow—the former at wave-length ·59 and the latter at about ·56. The values for the ratio daylight /C_2H_2 are approximately as under:—

Wave length . .	·725	·64	·62	·59	·56	·53	·46	·44	·42
Nichols (average) .	·45	..	·865	1·00	..	1·34	2·07	..	2·59
Voege (approximate figures)	..	·73	..	..	1·00	1·16	..	3·7	..

So far as the comparative colour values of our artificial light-sources are concerned, Voege's figures indicate that illuminants of the incandescent type—gas and electric—do not contain much more than 20 per cent. of the blue actually present in diffused daylight; and this is surely comforting if rays at the blue end of the spectrum are to be regarded as physiologically objectionable. Ordinary arc lamps contain some 45 per cent.; but Dr. Voege's data being less complete do not appear to indicate the wonderful excess of violet in the region of wave-length ·425 shown by Dr. Nichols. At the other end of the spectrum, the Welsbach light shows, according to Voege, about 1·2 times as much red as that in diffused daylight; electric lamps, about 1·7 times; and arc lamps, 1·35 times.

In varying degree, Dr. Nichols' data corroborate these figures; but they go further, inasmuch as they disclose the peculiarities of artificial lighting sources—such as the effect of selective radiation. Generally speaking, most of the different illuminants appear by the curves to have greater relationship between themselves in the relative proportion of their colour-waves than they have with diffused daylight; but the difference in the intensities of the two kinds of illumination is partially attributed to the greater diffuseness of the latter. It may be remarked in passing, in view of the comparatively small ratio of blue rays in incandescent light sources to daylight, that the curve for the ordinary oil-lamp—regarded as a soft and safe light—shows a still smaller proportion of these waves.

The whole of the data given by Dr. Nichols in his contribution is well worth close study; and if eventually we have it in our power to vary and control the spectra of artificial illuminants, the information resulting from his research work will prove a valuable addition to our knowledge on the subject.

GAS SCIENCE FOR SCHOOL CHILDREN.

A Stockton Experiment.

DETAILS have reached us of a very interesting and highly commendable scheme for supplementing the ordinary elementary school curriculum, over which Mr. Matt. Dunn, the Assistant-Manager of the Stockton Corporation Gas-Works, is employing a goodly proportion of his leisure hours. Mr. Dunn belongs to the modern school of gas managers. He has studied and mastered the theoretical as well as the practical side of the science of gas, and has the whole history of gas and gas lighting at his finger-ends; and his lectures on all these subjects are in great demand at Stockton, Middlesbrough, and other large industrial centres in the North-Eastern district. His little scheme for sharpening the intellects of elementary school children by giving them an insight into the process of gas manufacture has been in operation for some time; but with characteristic modesty he has said nothing, or as little as possible, about it, and even now many members of the Educational Authority are in ignorance of the excellent work which is being carried on.

Mr. Dunn's *modus operandi* is to invite the senior boys—irrespective of class or creed—from the different schools in the town to the gas-works, where they spend two or three hours viewing a small gas plant, which is thoroughly dissected and fully explained—the action of the component parts in the process of the manufacture of gas being pointed out. Close at hand is a sketch plan of the miniature plant; and during the demonstration the students are permitted to make hand sketches from a series of sectional perspective drawings, illustrative of its component parts. Notes are taken as the system is carefully explained by Mr. Dunn in as elementary a form as possible; questions are invited and answered; and after a close examination, the plant is put into operation, and gas manufactured. When the lecturer is satisfied that the boys fully understand the process of manufacture, and the uses of the various parts of the machinery in that process, they are taken over the works proper, when the system of gas making and recovery of residuals is exhaustively dealt with. Parts of the machinery corresponding to those in the model plant are pointed out, for the purpose of reminding the students of their action and the functions they fulfil. This inspection of the actual work in operation, following upon the minute dissection of the carefully designed model plant, enables the boys to form a sound idea as to the modern process of gas manufacture; and in every instance this is evidenced by the excellence of the essays subsequently written by the boys.

Such demonstrations must of necessity encroach very greatly upon the leisure time of the lecturer; but Mr. Dunn has made the work a pet hobby, his only desire being to serve the interests of the boys by adding to the sum-total of their knowledge. The visits to the works are only the first half of the programme. Mr. Dunn subsequently arranges for the boys to attend the lectures which he delivers under the auspices of various societies and institutions, insisting with the promoters of the lectures that the lads shall be invited and seats reserved for them; his aim being to follow up the practical demonstration by giving the students an insight into the higher stages of the science. It is especially interesting to note that some of the boys are so keen in the matter that they have paid three or four visits to the works, specially to study the operation of the plant in its relation to the subject of a forthcoming lecture. Nor does Mr. Dunn stop here; for he offers prizes—usually bronze medals, suitably inscribed—for the three best essays by the scholars of each school. A very keen and lively interest is taken in these competitions; and in a quiet way an immense amount of good and useful educational work is being done in the interests of the rising generation of the town. In this way, over forty prizes have been from time to time awarded; and it may unhesitatingly be said that if these papers could be collected (as there is a possibility of them being), they would delight even the severest critic by the amount of intelligence displayed, and the remarkable grasp of the various subjects of which, taking into account their years, the students give evidence. Considering that the demonstrations and lectures are of such short duration, it speaks volumes for the ready perception of the boys on the one hand, and the explanatory abilities of the lecturer on the other.

Such a scheme is worthy of high commendation and of emulation; and one which might profitably be introduced in every industrial centre. To use Mr. Dunn's own words, he does not expect that all the students will eventually desire to enter the gas profession; but the information and the grounding they receive in this particular subject is given with the idea of strengthening their inclination towards the adoption of some business or trade in which they may apply their talents with success. There is reason to believe, also, that the demonstrations and lectures have created considerable interest in the homesteads of the several families represented; and much good can be traced to the advice and service rendered by the little students in their homes in the manipulation of gas to their several requirements, as all the most economical methods for its use are instilled into their minds by the lecturer. By this means, the students become eventually missionaries in support of the advantages of gas lighting and heating, and its superiority over other forms of illumination.

By the death, on the 2nd inst., of Dr. Theodor Peters, the Society of German Engineers has, says "Nature," lost its Director. During the greater part of his connection with the Society, extending over a period of 25 years, Dr. Peters was identified with all the changes made in the important institute under his guidance, and notably with the improvement and augmentation of the journal, the "Zeitschrift des Vereines deutscher Ingenieure," the prosecution of systematic researches on points of mechanical and engineering interest, and the publication of such reports, not only in the journal, but as independent pamphlets.

The fortieth meeting of the Eastern Counties Gas Managers' Association will be held at Leighton Buzzard next Thursday. The members and friends will assemble at the gas-works, where, by the kindness of the Chairman and Directors of the Leighton Buzzard Gas Company, they will be entertained at luncheon. After this, brakes will be in readiness to convey the party to "Ascott," the seat of Mr. Leopold de Rothschild, who has given permission for the grounds to be open for inspection, and for the business meeting to be held in the Pavilion. In addition to the formal business, the new President (Mr. C. F. Ruggles) will deliver his Inaugural Address; and Mr. John Young, of Hull, will read a paper on "Tar-Distilling in Medium-Sized Gas-Works." In the evening there will be a dinner at the Swan Hotel; and the following day a visit will be paid to the new works of the Davis Gas-Stove Company, at Luton.

DISCUSSION ON THE CARBONIZING PAPERS AT THE GERMAN ASSOCIATION MEETING.

(*Continued from p.* 706.)

At the close of Professor H. Bunte's remarks, Herr Knoch, of Lauban, said that though he could not speak of carbonizing chambers from experience as long as that gained at Munich, he had, however, had ten weeks' work with a chamber erected at Halberstadt by the firm of M. Knoch and Co.; and in the main he was able thereby to support Herr Ries' testimony as to chamber carbonization. The make of gas increased with the temperature. At the maximum of about 1425° C., "Hugo" unsorted coal gave as much as 13,921 cubic feet of gas per ton, and turn and turn about with Mathias-Stinnes nuts yielded an average of 13,276 cubic feet per ton. For four weeks, in which the temperature was kept as low as 1220° to 1250° C., 12,020 cubic feet of gas per ton was obtained on the average. It was intended shortly to try English coal in this chamber, and also to erect a chamber of larger dimensions than the present one. In regard to the admission of steam, it was true that there were no results for carbonizing chambers comparable with those for vertical retorts; but it was also well to remember that so far carbonizing chambers 20 feet or more in length had not been tried. The longer the chambers the greater would be the pressure, and the conditions would also be changed in other respects. The resistance to the steam, however, need be neither greater nor less than in modern water-gas generators; and the problem of the admission of steam to carbonizing chambers would certainly shortly be solved. The Halberstadt chambers had not been out of action for a single hour in the ten weeks, for the removal of scurf. The deposit had not so far exceeded the thickness of pencil graphite, and had been knocked away in a few minutes. It was hoped that by next year it would be possible to report more in detail on the work of the Halberstadt chambers.

Herr Buhe, the Manager of the Duisburg Gas-Works, said that he had had vertical retorts in use for eight months, and in that time had had absolutely no stopped ascension pipes. His results were similar to those reported by Herr Weiss, of Zürich, and he need therefore only say that the vertical retorts had given him the greatest satisfaction. Duisburg had previously suffered badly in respect of naphthalene obstructions; but since the vertical retorts had been in use, there had scarcely been one, notwithstanding the unfavourable conditions of the past winter. The naphthalene washer hitherto used was now being dispensed with. As inclined retorts were in use as well as the verticals, it was impossible to draw more precise conclusions. It was not feasible from an experience of only rather over 250 days to form a judgment as to the life of the vertical retorts. In regard to scurfing, he would be glad to hear from others at what intervals—two, four, or eight weeks?—the 30 minutes which had been named as the time occupied in scurfing had to be devoted to it.

Herr Prenger, the Manager of the Cologne Gas-Works, said that the keen competition between the vertical retort and the carbonizing chamber was very welcome. In view of the importance to the gas industry in its struggle with electricity of a satisfactory solution of the carbonizer question, it was gratifying to note that many towns had not hesitated to undertake trials of novel types on a large scale. A communication such as that of Professor Drehschmidt, setting forth the respective merits of the two systems of carbonizers according to his views, was very valuable. But on many points the opinions of technical men differed. For instance, the speaker considered, in opposition to Professor Drehschmidt, that the introduction of steam into the vertical retorts was most important and economical, especially for gas-works of moderate size. The economy depended not merely on the settings themselves, but on the possibility of varying over a wide range the description of coal used. In each case it must be settled independently whether it was better to secure a high make of gas per ton of coal by prolonging the period of working off, and making water gas, or to increase the productive capacity of the settings by working off the charges quickly and admitting no steam. Many private gas-works were still hampered by prescriptions in regard to the illuminating power of the gas supplied. The vertical retort had the advantage that it could be worked to meet any such requirements, or it could be worked differently according to the time of year—*i.e.*, without admission of steam in the summer, but with steam in the winter. The speaker also differed from Professor Drehschmidt's views as to the difference in the heats of the vertical retort and the carbonizing chamber. It was not true that the coal was more thoroughly carbonized in the lower than in the upper part of the vertical retort. Owing to the conical shape of the vertical retorts, there was more coal in the lower part; and more heat was consequently needed there for its carbonization. The gradual decrease in the heats upwards favoured uniform carbonization, and, moreover, facilitated economical utilization of the heat of the fuel. Economy of heating could be secured better with a gradual fall from the initial point at which the heat was applied to the retort than with the maintaining of the whole chamber at a uniform high heat. In regard to stoppages of ascension pipes, at Cologne the pipes were cleared right through every three or four days. At first, the stoppages were troublesome; but it was found that they depended on the coal and, more particularly, on the heats of the settings. Herr Ries' statement that the carbonizing chambers needed only half-an-hour for scurfing every 30 or 35 days required elucidation, as it did not seem possible to remove scurf in that time unless it were loose. How long previously had the chambers been standing idle? At Cologne, eleven hours, or one charging-period, were devoted to burning off and removing the scurf. The loss due thereto was not serious—at Cologne, perhaps, 3 per cent. of the whole output. The vertical retort coke was heavy and firm, and did not burn readily enough for use in small household stoves. This was a very important question, of which the solution had still to be sought. In conclusion, the speaker said that, in his opinion, the carbonizing chamber was not well adapted for small, and perhaps not even for moderate-sized, gas-works.

Herr Terhaerst, the Manager of the Nuremberg Gas-Works, said that in the exhibition of naval architecture at that time open in Berlin, there was a model of a coke-oven plant equipped for the recovery of bye-products which had interested him very much. The oven-chambers were designed primarily to produce good metallurgical coke which should be hard enough to stand the load to which it was subjected in the blast-furnaces; but in the second place the ovens were designed to recover the valuable products—tar, benzol, and ammonia—to the largest possible extent. The quality of the gas made was only considered in so far as it affected the recovery of these valuable products. The quality of the coke and other products depended on how the ovens were worked; but the firmness and purity of the coke increased with the heating surface of the ovens. Carbonizing periods of 24, 30, or even 48 hours were adopted. It was known that, working at high heats, the methane and benzol contained in the gas were decomposed by passing through the layers of hot coal, and that a feebly luminous gas, rich in hydrogen but poor in benzol and methane, resulted. The character and quality of the tar were also affected by high heats in the ovens. It was more nearly dissociated as the heat was increased. These effects were intensified by the rapid shrinkage of the block of coke from the walls of the oven when it was worked at high heats, as the heavy hydrocarbons then traversed the hot walls and were split up. High heats also resulted in much naphthalene and scurf being formed, as well as in an increase in the proportion of sulphur compounds other than sulphuretted hydrogen in the gas. At the same time the yield of ammonia was reduced. Notwithstanding the general recognition of these facts, which indicated that not only the quality of the coal, but also the method of distillation greatly influenced the production of metallurgical coke and the yield of bye-products, the managers of coke-oven works were by no means agreed as to the best system of coke-oven to employ. It would appear that the system or type of oven itself was of less importance than the manner in which it was worked. Just as vertical, inclined, narrow, and broad coke-ovens, with or without regeneration, continued to be used, so it was likely that inclined horizontal and vertical retorts would continue in the gas industry. The speaker had followed a somewhat different mode of working for some years past. Instead of directly producing a poor gas suitable for distribution, he made a comparatively rich coal gas with but little expenditure of fuel in the retort furnaces, and had then reduced it to a particular calorific power by admixture of simple water gas. He had thus secured a satisfactory yield of bye-products, and had also been better able to take up the fluctuations of gas consumption and had extended the life of the settings. Using a good gas coal, he obtained about 10,765 cubic feet per ton of coal at moderate heats, and adding about 20 per cent. of water gas on the average, he secured a gas uniformly of a net calorific value of about 5000 calories per cubic metre at 0°C. and 760 mm. (532 B.Th.U. per cubic foot at 60° Fahr. and 30 inches). Thus from a ton of coal carbonized he obtained about 12,740 cubic feet of gas. If, however, a gross calorific value of 5000 calories per cubic metre (532 B.Th.U. per cubic foot) were taken as adequate, as Professor Bunte had suggested, the yield of gas would be considerably increased. Thus economy of working with little labour was achieved, just as was claimed for the carbonizing chambers and the vertical retorts, and the economy was, in fact, proved by the high net profit made by the Nuremberg Gas-Works. Engineers who contemplated re-building or extending their gas-works would find it of interest to obtain existing figures as to how economically they could work with the existing apparatus. In regard to the coke, there was generally a good demand for the comparatively soft gas coke, and it should be borne in mind that the hard coke as obtained from vertical retorts wore the coke-breakers much more than soft coke.

Dr. Bueb, of Dessau, said that the communications made by him on the vertical retort had been based exclusively on facts, and that his guiding principle had been not to bring out any innovation in the working of the retort which had not been tested for at least one year in his Company's own gas-works. He could have wished that those responsible for the carbonizing chambers had followed the same lines. The speaker's varied experiences had taught him that it was extremely rash to prophesy that when a retort was doubled in size, the quantity of gas produced in a given time would be doubled. Proof was still wanting that the Munich carbonizing chambers having a productive capacity of 2700 cubic metres per diem would have double this capacity when they were made twice the size. Practical experience with the vertical retort had taught that it was a great mistake suddenly to enlarge its capacity. All sorts of unforeseen evils ensued, which could only be overcome with difficulty or with the sacrifice of other advantages. Since the present pattern of vertical retort

had been brought out, further trials had been made both by the German Continental Gas Company and by the Imperial Continental Gas Association, under Mr. Körting's guidance. The object of these trials was to increase the capacity of the retorts. They were not yet completed, and it would only be possible to give a trustworthy report on them in the course of a year. It could, however, be stated now that no economically improved result had been attained by increasing the size of charge. The trials which were being carried out at Mariendorf and Dessau with two different sizes of retorts proved that as the capacity of the retort was enlarged, the fuel consumed in heating it showed a relative increase. The speaker would therefore warn his hearers not to pin great faith on the enlargement of the carbonizing chambers. The figures now published for the working on a large scale at Zürich and Mariendorf* might, in the speaker's view, be taken as the practical limit of what was attainable. If the retorts were enlarged, the figures would not be improved but probably deteriorated. It should be remembered that three years ago no gas engineer considered that such figures could be obtained on a large scale of working.

Referring to Herr Ries' statement that the vertical retort did not appear to work on a different principle of carbonization from the carbonizing chamber, Dr. Bueb said that the two systems seemed to him to differ fundamentally in respect of the mode in which they were heated. The carbonizing chamber, like inclined retorts, was heated to the same temperature over its whole height; whereas the vertical retort had a temperature diminishing from the bottom upwards. This, together with the complete filling of the retort with coal, constituted the principle of the vertical retort system. These two important factors had enabled him to obtain a gas which was almost wholly free from naphthalene and a tar which was more nearly an oil than a thick tar. If only 20 inches at the top of the retort were left without coal, the conditions were entirely altered. There was then a superheating chamber which the gas must pass through, and naphthalene and thick tar resulted. It should be pointed out that vertical retorts could not be worked according to a particular scheme of turning cocks in order, but that considerable intelligence must be applied to obtain good results with them. It had therefore become of extreme importance that the staff should be properly trained to work the settings properly when high heats were used. This remark applied to either vertical retorts or carbonizing chambers or to any other settings worked at high heats. What could be accomplished with good supervision of the settings was shown by the figures published from Mariendorf and Zürich. The gas industry ought to be extremely grateful to Mr. Körting for having placed his model plant at Mariendorf at the disposal of gas-works who wished to give their retort-house foremen an opportunity to learn how the new vertical retorts should be worked. It was only by rational working of the vertical retorts that they could be expected to show to the full their great superiority over all other systems in respect of a proper return on the capital expended in the retort-house. From the point of view of national economy it was of immense importance that the maximum of gas should be produced with minimum expenditure of capital.

Herr Knoch, of Lauban, speaking a second time, said that he had been interested to learn from Dr. Bueb's speech how difficult was the working of vertical retorts, and what dangers were involved in it if the advantages were not to be nullified. He might assert nearly the opposite in regard to carbonizing chambers. The chamber, in the single chamber system in particular, was accessible on all sides; so that the simplest retort-house foreman could at a glance satisfy himself as to its condition, quite apart from the fact that the chamber was at a temperature lower by about 200° Fahr. than the vertical retort. Thus the danger of burning down the setting did not exist with the carbonizing chambers. As to tar stoppages, he might mention that when the carbonizing chamber was worked in the open in cold weather stoppages were experienced; after it was covered in, they were practically absent. The ascension pipes were cleared through easily every fourteen days.

Herr Kobbert, the Manager of the Königsberg Gas-Works, said that Professor Drehschmidt had questioned the economy of the admission of steam into vertical retorts, while Professor Bunte had questioned the utility of water-gas plant. These questions raised new points of difficulty which ought to be settled. Herr Prenger, in the results which he published on 50-hour working trials of vertical retorts at Cologne (see "JOURNAL," Vol. CII., p. 562), had furnished material from which conclusions might be drawn as to the economy of the admission of steam. The speaker had taken out the necessary figures, and would send them for publication (see *ante*, p. 441). Briefly, Herr Prenger's figures showed that water gas was not made simultaneously with coal gas in vertical retorts, but that after the plant had been acting as a coal-gas plant it was for the time being used for a further period as a water-gas generating plant, during which time it was not producing coal gas. The question really was whether a setting of eighteen vertical retorts cost more or less than a water-gas generator of the same productive capacity. There could be no question but that water gas could be more cheaply made in an independent generating plant. (Herr Kobbert's views on this point have been already given more fully in the "JOURNAL," see *ante*, p. 441.)

Mr. E. Körting, of Berlin, said that one of the most important points for consideration was the question whether a chamber or a retort should be used for carbonization. He had been startled to learn that at Munich only 95,000 cubic feet of gas could be produced per setting per diem with considerably more expenditure of fuel. Their own attempts at Mariendorf to enlarge the retorts into chambers had been attended with a similar result. The carbonizing periods had been relatively greater, and more fuel had been expended. Consequently he was forced to come back to the position that, technically, the retort could not be surpassed for the gasification of coal. The enlargement of the retorts involved all the apparatus being more cumbersome and more costly. The lids or doors became larger and heavier, and, as they could no longer be manipulated by hand, mechanical arrangements had to be introduced. The chambers had to be of more solid and massive construction. To sum up, after making exhaustive trials, the speaker had determined that next year he would erect more retorts and not vertical chambers. A second most important point had been raised by Professor Drehschmidt —viz., as to whether it was more advantageous to produce water gas independently or in the retorts. The speaker had come to an opposite conclusion to Professor Drehschmidt on this point. He had before him not only the technical but the financial results of two years' working, and he had found that it was very much cheaper to produce water gas in the retorts. It should not be forgotten that a great part of the necessary heat was in that case already stored up in the coke. By the admission of steam much more gas was made per retort than if no steam were admitted. Thus the water gas made in the vertical retorts was in the nature of an addition to the normal make. Nothing need be allowed for special cost of plant because the period of carbonization had to be extended by an hour. According to the method of working followed for the last two years at Mariendorf, 12 hours were given to working off each charge. At 10½ to 11 hours after charging, carbonization proper was complete; and it was practicable and extremely economical to finish by making water gas. The financial results achieved were far superior to those referred to by Herr Terhaerst for the working of retorts at lower heats in conjunction with the independent manufacture of water gas.

With regard to stoppages of ascension pipes, the admission of steam to the retorts had considerably reduced these, as the temperature in the retorts was considerably lower in the last hour or two. At Mariendorf, the gas exits of the retorts were cleared only once every seven days, and commonly this was done only as a matter of routine. The speaker went on to refer to the importance of uniformity in working, and to the necessity of distributing the gas production over the whole day. Hitherto a gas of 5000 to 5400 calories per cubic metre calorific power—say, 530 to 570 B.Th.U. per cubic foot—had been produced; but now that the lower figure was worked to, the quality must naturally be kept uniform. For some years past a gas of 530 B.Th.U. per cubic foot had been distributed. It would be very difficult and troublesome to test continually to see that the right calorific power was maintained; and trouble would ensue if a gas were made at night time which differed in calorific power from that made in the day time. With several gasholders in use on a works, it would be necessary continually to compute how much day-made gas and how much night-made gas each holder contained, in order to ensure gas of uniform quality being distributed. The conditions entailed by this procedure would be impossible of fulfilment. The idea that night work could be dispensed with should be absolutely given up.

The authors of the various communications under discussion then proceeded to reply briefly to the points raised in it. Professor Drehschmidt said that in regard to the admission of steam in the retorts, it was a case of one opinion against another. He had based his own contentions on the fact that sufficient water gas could not be produced in the vertical retorts, and that, consequently, water-gas plant would still be required. Also it was not impossible that water gas could be made in the carbonizing chambers, though so far it had been claimed as an advantage belonging only to the vertical retort. It would be going too far at this stage to discuss Dr. Bueb's remarks on the advantages of the unequal heating of the vertical retorts, but there appeared to be some confusion between the temperature and the quantities of heat.

Herr H. Ries, of Munich, said that, with reference to the questions raised by Herren Buhe and Prenger, as to the scurfing of the carbonizing chambers, he had previously stated that one chamber could be completely scurfed in from 30 to 40 minutes. This was quite true, and the scurfing took place once every four to six weeks. The procedure was quite simple. The upper and lower doors were opened slightly, so that fresh air passed through the chamber in an upward direction. In 15 minutes the slabs of carbon on the walls of the chamber appeared to be loosening; and it then only required slight mechanical assistance with (say) a shovel or similar instrument to remove the leaves of carbon from the walls. It fell down in plates up to a size of 40 inches square. One place in which the scurf was specially deposited was the roof of the chamber, where it might attain a thickness of perhaps 4 inches if its formation were not checked at the right time. This could very easily be done with a rake, by scraping off the deposit on the roof while it was still uncompacted—about once every eight days. Scurfing of the chambers was an extremely simple matter and free from any risk, as the carbon fell out at the front of the retort where no workmen were standing. It appeared to the speaker that the scurfing of vertical retorts, whether done from

* See "JOURNAL," Vol. CII., pp. 807, 813.

the top or the bottom, could not be so simple or free from risk. Dr. Bueb had said that it was not economically an improvement to enlarge the carbonizing chamber. This might be true of vertical retorts. With carbonizing chambers, however, an improvement of the economical conditions was assured under all circumstances. There was an almost ideal utilization of the heat supplied. At the Munich Gas-Works, chambers of larger dimensions could not be constructed; but the Hamburg Gas-Works had erected settings of almost double the capacity of those at Munich, and it was reported that the percentage of fuel consumed in heating was considerably smaller than that realized at Munich and reported on in the trials made by the Carlsruhe Experimental Works. This practical proof far outweighed the criticism. In regard to the management of the settings, the new chambers certainly needed careful supervision and treatment; but all the newer systems of retort-settings were in many respects more troublesome than the old. Workmen were required not so much for mechanical work as for intelligent operation; and it would be a useful thing if technical schools would train men as retort-house foremen as well as fitters. Much had been said in the discussion as to the effect of want of uniformity in the gas; but this appeared to have been already adequately dealt with in the speaker's paper read before the Association.

Herr Weiss, of Zürich, referred to the remarks of Herr Terhaerst with reference to the sale of coke. He was not jesting when he stated that at Zürich the coke from the vertical retorts had been sold at a better price than that from the inclined retorts. The coke from vertical retorts and carbonizing chambers was considerably more compact than that from horizontal and inclined retorts; and it should fetch a better price even in Berlin. In Zürich there had been a few cases where the heating appliances had a bad draught and would only burn ordinary gas coke. They would not burn Ruhr patent coke; and, similarly, they would not burn the coke from vertical retorts. The fact that vertical retort coke was equally valuable with Ruhr patent coke had been established by trials made by the Federal Fuel-Testing Laboratory at Zürich, as well as by practical trials in the furnaces of the firm of Gebrüder Sulzer, at Winterthur. A higher price was now being asked for vertical retort coke than formerly. The general management of the Swiss Federal Railways had decided to use vertical retort coke in place of the Ruhr patent coke hitherto used; the respective prices being 35 frs. per metric ton for vertical retort coke and 50 frs. for Ruhr patent coke. Further comment seemed superfluous.

THE BRITISH ASSOCIATION GAS PAPERS.

Points from the Discussion.

In last week's issue of the "JOURNAL" (p. 723), we gave some extracts from three papers on the subject of gas which were read and discussed together at the recent meeting in Dublin of the British Association; and these are now followed by a notice of the remarks in the discussion which are of more general interest to our readers.

Mr. WILLIAM CROSSLEY (Manchester) remarked that Captain Sankey's paper on the "Utilization of Peat" was of particular interest to him, as his Company had for a long time been engaged in solving the problem of using peat as a source of fuel for gas-engines. He could confirm from his own experiments some of the figures given by Captain Sankey. When first it was suggested that they should use as fuel for the producer peat containing 60 per cent. of moisture, the idea was regarded as impracticable; but their experiments had proved that a good and economical gas could thus be obtained—even with the use of plant designed for coke, and therefore not quite suitable for the new fuel. He had made careful estimates of the results to be anticipated from sulphate works of various outputs; and he submitted the following calculations: Plant dealing with 10 tons of dry peat per hour would cost £50,000. In their original experiments, peat that contained 2·2 per cent. of nitrogen yielded 140 lbs. of sulphate of ammonia per ton of dry peat; but with plant better adapted for the purpose—the apparatus originally employed was not very suitable—they obtained from the same peat 170 lbs. of sulphate per pound of the dried fuel. This latter figure was equivalent to a yield of 80 per cent.; and he believed that an even better result could be secured. However, taking the yield at 140 lbs. per ton, and employing plant gasifying 10 tons of peat per hour and costing £50,000, there would (after allowing for the writing-off of the capital in six years), on the data taken, be left a profit of £24,000 per annum. In this calculation the net cost of sulphate was taken at £5 18s. per ton—*i.e.*, interest, maintenance, and repairs, 15s.; labour and management, 15s.; collection of peat, £2 8s.; and sulphuric acid, £2. Putting the selling price at £11 10s., there was left a profit of £5 12s. per ton. It was, however, necessary to bear in mind that Irish peat generally contained less than 2·2 per cent. of nitrogen; a more usual amount being 1·8 to 1·6 per cent. If the latter figure were adopted, they might expect 100 lbs. of sulphate per ton of dry peat. The labour charges would under these circumstances go up, making the total cost of the sulphate £7 9s., and leaving a profit of £4 1s. per ton. The cost of getting the peat was a little uncertain, and might be more than was taken in his estimate; but it certainly would not be large enough to reduce the profits below £3 per ton, in which case £6000 a year profit would be realized on an outlay of £50,000, without reckoning anything for the value of the gas or the other bye-products obtainable. With peat containing 3 per cent. of nitrogen, the net cost per ton of sulphate would be £4 19s. It would be seen that the author had made out a very good case for his scheme, since the gas would be obtained free, and there would yet be a good profit on the sulphate and other bye-products. As to the electrical portion of Captain Sankey's proposals, he would merely remark that the current was secured for nothing. Mr. Robson, in his paper on "Suction-Gas Plants," had made some interesting remarks on the progress of the suction-gas producer, the introduction of which had been an immense boon to the gas-engine industry, which it appeared possible at one time was going to be stamped out. There was, for instance, the Manchester Corporation, who were selling current at what seemed to many to be below the cost of production. But the suction-gas plant had saved the situation—though at the outset it met with fierce opposition. Gas managers had threatened to boycott customers who installed these plants—refusing to supply them with coal gas if they used suction gas. The economy obtained, even with small plants, was most remarkable; and in steady running, the fuel consumption went down to $\frac{5}{8}$ lb. of anthracite per B.H.P. per hour.

Mr. ALEXANDER SIEMENS (London) said he wished to correct a statement of Mr. Dowson's, to the effect that the original Siemens producer was of the suction type, and that Sir William did not use pressure producers. In 1867 two sets of producers were being made, he remembered; and in one of these a steam-jet was employed for the purpose of enriching gas, to which the author had referred. Now steam-jets were being used with Siemens producers to draw in the products of combustion and force them again through the fire of the producer. A Benier suction-gas plant which he had had going for nearly ten years had proved a great success. He suggested that the problem of a bituminous suction producer might be solved by using a very long and large overhead cooling pipe, in which the tar would condense out, while there would be very little negative back-pressure on the engine. In this way the bye-products could be collected economically. With reference to Mr. Crossley's remarks, a profit of £6 per ton of sulphate looked very nice; but the public would object to pay over £11 a ton for sulphate which cost about £5 to produce.

Mr. CROSSLEY pointed out that the sulphate market was wide and well established, and would not be disorganized by the additional quantity they proposed to throw upon it.

Mr. RIGBY (of Messrs. Crossley Bros.) exhibited a diagram of an ammonia recovery gas plant suitable for working with peat fuel, in which he said the operations of gas cooling and washing and the extraction of the ammonia (which in the Mond plant were distinct) were combined—the same liquor being used throughout. A suggestion that had been made to dry peat by first heating it in a boiler was interesting; but they would want to know what effect this would have on its valuable constituents. So far, sulphate of ammonia had been the only one of these that had received much attention; but a promising process was now being tried, from which it would seem that acetic and other acids might also be recovered—the final yield being 5 per cent. of sulphate, 1 per cent. of acetate of lime, ½ per cent. of wood spirit, and 5 per cent. of tarry products. He agreed with Mr. Robson that down-draught plants usually did not work well.

Mr. DAVID SHERLOCK remarked that in taking the 3 million acres of peat in Ireland one point had been overlooked—namely, that there were three different sorts of peat. In a bog 15 feet deep, it would only be from the bottom 5 feet that valuable products could be extracted; and it would therefore be necessary to remove 15 feet to get 5 feet of suitable peat.

Mr. CROSSLEY said his experience was that the top layer was the richest in nitrogen.

Mr. SHERLOCK replied that Professor Moss had often examined samples, and had found no nitrogen in the top layer, while there was 3 per cent. in the lowest layer.

Captain SANKEY, in replying on the discussion, said all the calculations in his paper were based on anhydrous peat—a product which was only seen in the laboratory. As to Mr. Sherlock's remarks, the top layer of peat was useful for various purposes; and the profits obtainable from it were sufficient to cover the cost of digging all the rest.

Mr. DOWSON said he already knew that Siemens had introduced steam into some of his producers; but in his paper he had had in view more especially the first type, in which the draught was produced by suction.

Mr. ROBSON, referring to the utilization of peat, remarked that the prospects were good, but caution was necessary. Gas-engine makers were greatly indebted to Mr. Dowson for the development of the producer.

The PRESIDENT of the Section (Mr. Dugald Clerk) said that no doubt the suction-gas producer had appeared at a very critical period of the gas-engine industry; but personally he had not met with such extreme opposition from gas managers as Mr. Crossley had described. At a very early stage of the manufacture, he had read a paper before the North of England Gas Managers' Association, in which he had pointed out that, between suction-gas plants and electricity, coal gas would be squeezed out for power purposes unless its price was substantially lowered. The price had gone down; and therefore at present manufacturers were in the happy position of having a threefold choice.

A CENTRIFUGAL SEPARATOR WITH BOTTOM DISCHARGE.

Heine's Patent.

The "Chemical Trade Journal" have recently given some particulars of the centrifugals of Gebr. Heine, now being introduced in the English market by Messrs. S. Bornett and Co., Limited, of St. Dunstan's Hill, E.C.

Our contemporary remarks: The appliance in most general use for removing mother-liquor from crystalline products—such as sulphate of ammonia—is the centrifugal. Many are still so designed that the dried material, after centrifuging, has to be shovelled out by the top of the basket. This is a tedious operation, and not conducive to the cleanliness of the product or of the apparatus. Attempts have therefore been made to design centrifugals from which the material could be discharged through the bottom of the basket. In most cases the latter is provided with openings, which are, during rotation, closed by slides. The clearance necessary for the easy working of the slides, however, permits mother-liquor to leak through, and eventually to reach the dried and discharged material. On the other hand, these clearances and the working faces of the slides are gradually covered by crystals; and as they are inaccessible for cleaning, the accumulation proceeds until the slides stick altogether.

These drawbacks are said to be entirely overcome in the centrifugals here illustrated. In fig. 1 the bottom of the basket slopes towards the centre, and is there provided with several large openings *c*. A conical hood *b* is placed over the openings, and bears on its periphery a packing-ring of suitable material—rubber, leather, or the like—secured in a groove and easily renewable. The apex of the hood bears a screwed handle *a*, which works on the end of the main spindle, and a few turns of which are sufficient to tighten the hood against the bottom of the basket. During charging and running, the hood completely and tightly closes the openings in the bottom; and when the operation is completed, it is loosened by a few turns of the handle *a*, and lifted out bodily—thus uncovering the discharge openings completely. The whole joint-face is exposed at the same time, so that it can be kept absolutely clean without trouble. This type of centrifugal is excellently adapted for all salts, even if the wet mass is of pasty consistence, and equally so whether the basket is charged while at rest or in motion.

The second type shown in fig. 2 has the basket supported from the main spindle by a number of pillars *e*. The bottom, *k*, is conical, and is raised and lowered by the screw-spindle *i*. In its highest position, it bears on the joint-ring *q*—thus closing the basket tightly. When it is lowered to the position indicated by the dotted lines, the whole periphery of the basket is open, and the material is discharged at once; so that this type is particularly well adapted for handling large quantities. The machine illustrated is provided with vertical shoots *p* for discharging into trucks, conveyors, or the like.

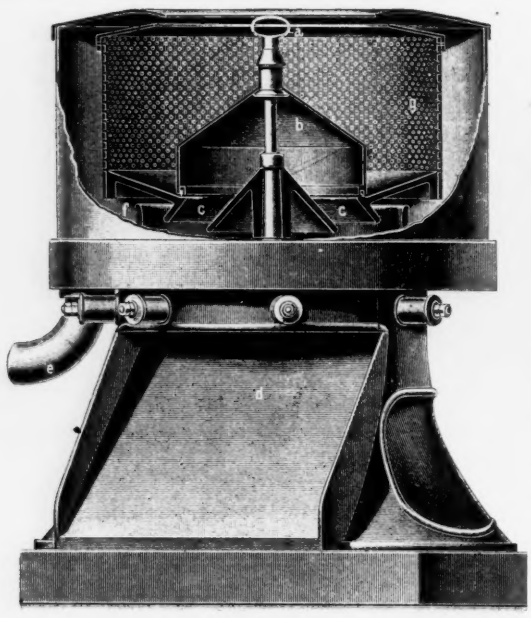


Fig. 1.

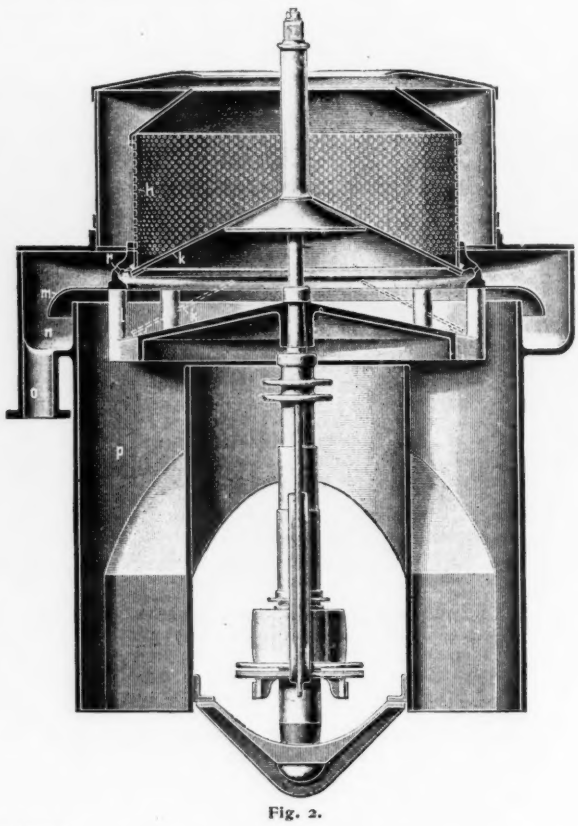
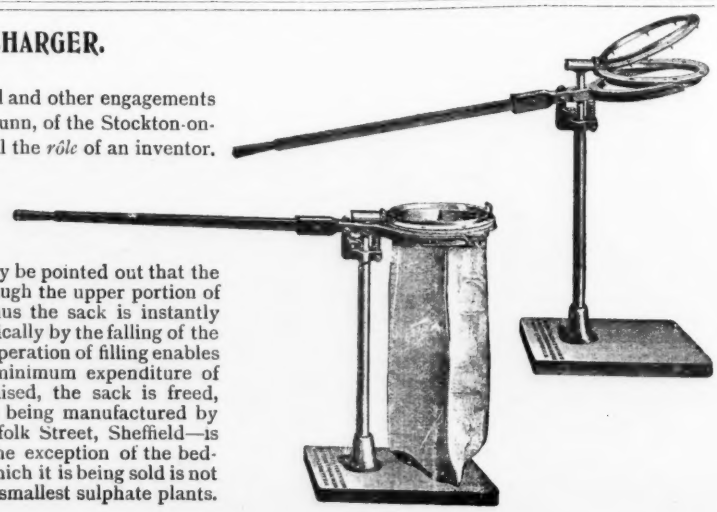


Fig. 2.

Heine's Centrifugals.

DUNN'S SACK HOLDER AND CHARGER.

In the midst of his ordinary duties, and educational and other engagements with which he has surrounded himself, Mr. Matt. Dunn, of the Stockton-on-Tees Corporation Gas-Works, is able to find time to fill the *rôle* of an inventor. No doubt through having himself experienced the need for such a contrivance, he has been led to design and patent a holder and charger for use when filling sacks with sulphate of ammonia or other heavy substance; and the accompanying illustrations are explanatory of the invention. It may be pointed out that the top ring is fitted with spikes; the spikes going through the upper portion of the sack, and through holes in the lower ring. Thus the sack is instantly fixed in the machine; the top being secured automatically by the falling of the upper ring. The movement of the lever during the operation of filling enables the sack to be sagged or charged tightly with a minimum expenditure of time and labour; and on the upper ring being raised, the sack is freed, and is ready for tying up. The apparatus—which is being manufactured by Messrs. Hattersley and Davidson, Limited, of Norfolk Street, Sheffield—is constructed of unbreakable malleable iron, with the exception of the bed-plate, which is of strong cast iron; and the price at which it is being sold is not such as to prohibit its use in connection with even the smallest sulphate plants.



ROUND THE WORLD—AND SOME GAS-WORKS.

By MAURICE GRAHAM.

[*Copyright in Great Britain and America.*]

X.—NEW ZEALAND (SOUTH ISLAND).

Travelling northward from Invercargill, Port Chalmers (at the entrance of Otago Harbour) is passed by the steamer, and beautiful views present themselves. From this Port to Dunedin is about nine miles; and the journey at high tide is done by water and at low tide by train.

Dunedin.

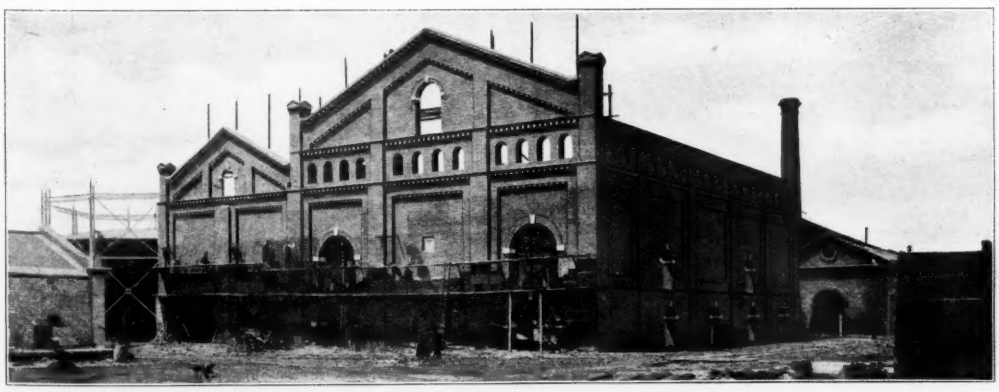
This is the ideal spot where one would naturally expect a Scotsman to found a town, surrounded as it is with hills and mountains. In fact, in this very hilly town builders must be put to considerable expense in first making a level foundation. However, it is all worth it, for the surrounding country offers exceedingly pretty views and the climate is healthy. Everybody appears to be blessed with independence and prosperity; and the absence of poverty and loafers is conspicuous. There is a good tram service of cable cars for the hills (the gradient of one hill being 1 in 3½), and electric trolley cars for the more level portions of the town. With Port Chalmers and district, the population is about 60,000.

The Corporation own the gas-works—having taken them over

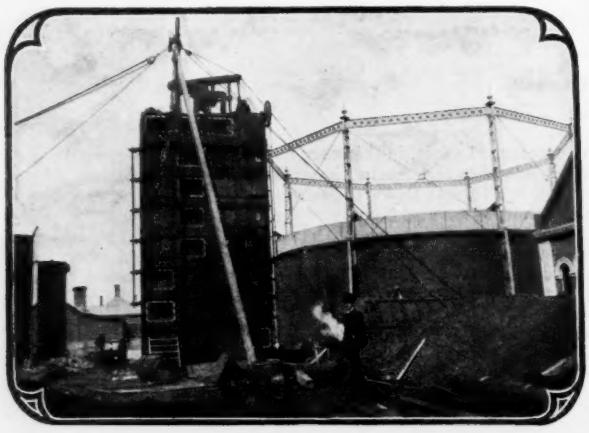
Photograph No. 88.—Dunedin Old Gas-Works under Reconstruction.

in 1876 from a Company which erected them in 1862. They have lately decided upon a complete reconstruction scheme, which is in progress at the time of writing [April]. The writer had the opportunity of comparing the old with the new, as the old plant was still working until the new scheme was fully completed. Photograph No. 88 shows the old gas-works, the cost of the reconstruction of which will amount to about £60,000.

The Engineer and Manager, Mr. John Hungerford, was trained under Mr. Robert English at Christchurch, N.Z. Previously Mr. Hungerford had taken honours in engineering and technology at the University in that city; so that he rapidly acquired an insight into gas matters. He came to Dunedin at a critical period, about twelve months ago; and many a time has he had to remain in the works all night so as to ensure the required make of gas. Directly he came, he commenced to remedy and patch-up the old settings of retorts, which, owing to their age, had given way at the main arches and thus had let down the hydraulic main. He therefore decided that he would put in temporary steel buckstays with cross supports, to take off the weight of the main and pipes, and keep a level seal by two tar towers at the end of the bench. This work was all carried out while the bench was under fire and making gas; so it must have entailed an enormous amount of worry and anxiety to Mr. Hungerford during these early days. The old horizontals were direct-fired, with only two or three regenerators. None of these will be in existence by the time these notes are published; they will be replaced by fourteen beds of eights, or 112 through retorts worked by De Brouwer machinery and heated by Mr. English's furnaces. The new retort-house being constructed is seen in Photograph No. 89. Its machinery will be supplied by Messrs. W. J. Jenkins and Co. Elevators and conveyors will take the coal from the 3000-ton stores, after it has passed through a breaker, and deliver it to overhead hoppers; there being one hopper per bed. The coke from the retorts will be quenched as usual in the hot-coke conveyors.

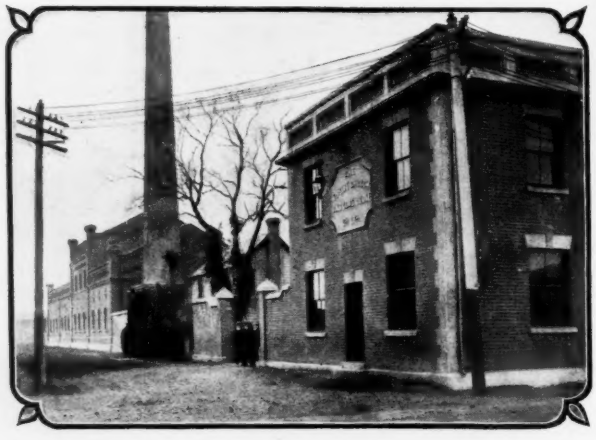


Photograph No. 89.—New Retort-House during Erection—It will be fitted with Mr. R. English's Furnaces and De Brouwer Machinery.



Photograph No. 90.—Purifying Machine in Course of Re-erection.

In passing round the works, one cannot help noticing the many temporary connections and arrangements necessitated by the reconstruction. The annular condensers, 30 feet high by 2 ft. 6 in. diameter, are of sufficient capacity for the new plant. The new exhauster-house contains the water-gas blower and two new sets of Waller's four-blade exhausters—all well placed. Messrs. C. & W. Walker's purifying machine and a "Standard" scrubber had been removed to new positions, and were in course of re-erection, as shown in Photograph No. 90.



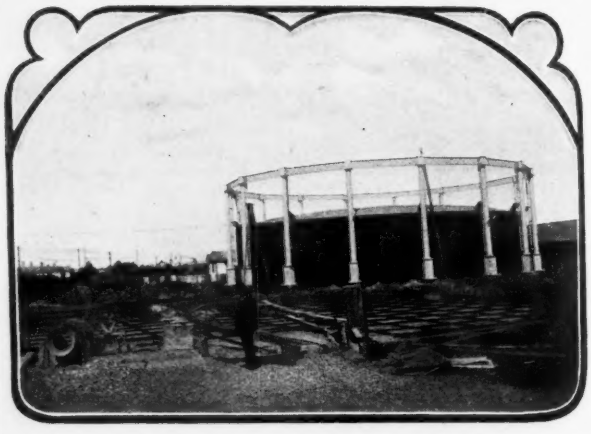
Photograph No. 92.—Entrance to the Christchurch Gas-Works.

The four purifiers, each 25 feet square, are in a covered ground-floor house. Oxide is the only purifying material used in them.

The station meters and valves are in a suitable building; and the three Braddock governors are in a house apart. This house was built by a Mr. Graham, for many years Manager here, and well known to gas students by the illustrations of Graham's condensers in technical books.

The gasholders are three in number—having a total capacity of 1,310,000 cubic feet. The writer saw the foundations being put in for a large new gasholder. The subsoil of the works is bad and water-logged, water rising to within 3 ft. 6 in. of the surface. This means having very solid foundations; and those seen were certainly of that description. Piles were driven to a depth of 20 feet, and around the top of each pile large stones were placed. The foundations were of reinforced concrete, with wire netting; and on the top, old rails in methodical order were laid at right angles, as seen in Photograph No. 91.

There is a carburetted water-gas plant on Messrs. Humphreys and Glasgow's system. It is in duplicate—one set being of 200,000 cubic feet and the other of 150,000 cubic feet per diem. The plant is somewhat handicapped by the rather inferior oil used, the price of which is high—6d. to 7¼d. a gallon. However, Mr. Hungerford cannot help but feel thankful that he had this plant in case of emergencies during all his anxious time.



Photograph No. 91.—Reinforced Concrete and Rail Foundation for New Gasholder.

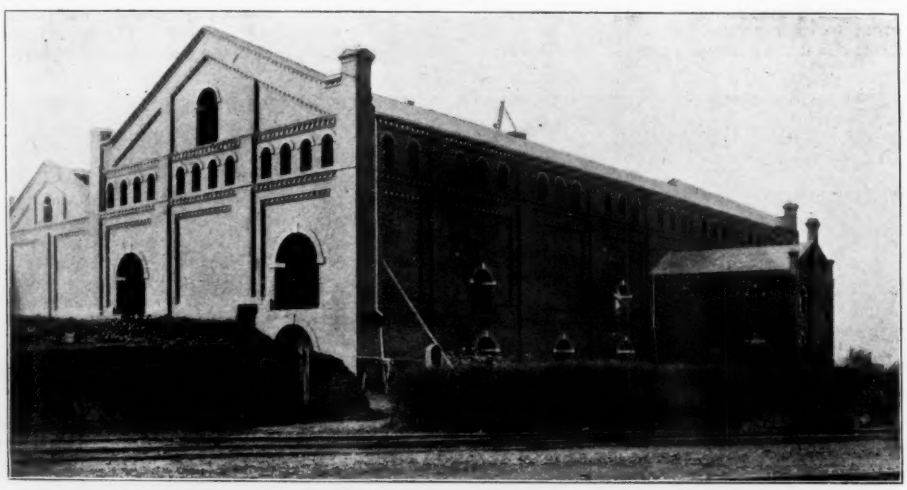
The Slur of Slot-Meters.

The Manager has recommended slot-meters to his Council; but the curious thing is that they are looked upon out here with some discredit—just as, in fact, they were in India and in Australia. The gas companies in many towns in Australia let it be known that if accounts are not paid, a slot-meter will be put in, and therefore some stigma becomes attached to their use. At the Victorian Gas Association meeting in 1907, one or two members declared that they only put slot-meters in where there were bad accounts. At Dunedin, they are evidently looked upon as carrying with them some reflection on the house in which they are installed. Mr. Hungerford is going to try and get over this difficulty by putting them in wholesale and without any receipts showing the amount of gas consumed.

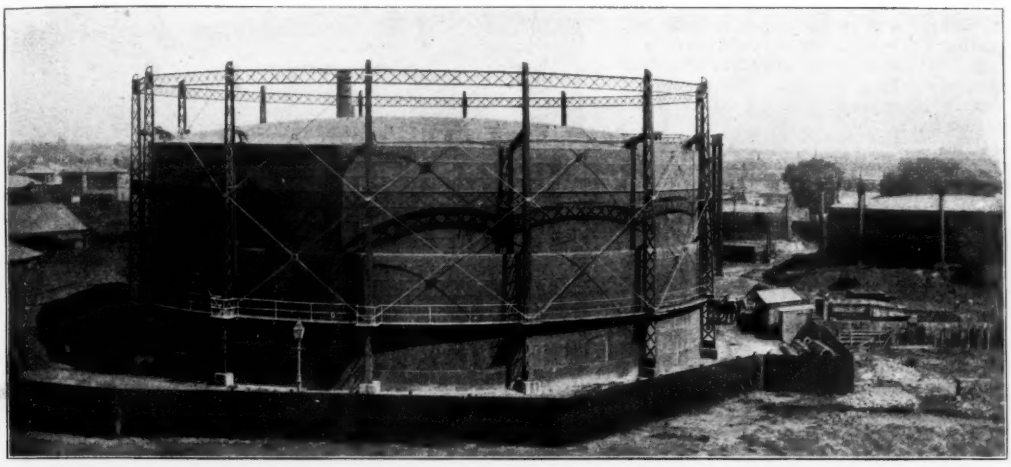
The whole of the public lighting—as far as it is done by gas—is by incandescent gas; but some of the out-townships, who do their own fitting, still use ordinary flat-flame burners.

Competition with Electricity.

The Municipality also control the electric light supply. They have recently purchased water-rights on the Waipori River, some 80 miles distant from the city. The present prospects of financial success from it are none too bright. It is expected to pay when the output is not less than 4000 H.P.; but now only an output of about 1200 H.P. is being generated. The Council, acting under their electrical expert's advice, have been prevailed upon to fix very low rates in order to obtain consumers and so justify the



Photograph No. 93.—The New Retort-House, with Coal Stores and Mess-Rooms adjoining.



Photograph No. 94.—The Largest Gasholder—450,000 Cubic Feet Capacity.

large installation made. The price of electric lighting averages about 3d. per unit, and for power about ½d. per unit. The future of both the gas and electricity undertakings can only be conjectured. The Gas Department showed about £8000 clear profit for the last half year, on a capital of £100,000. The estimated loss on the electrical installation is put at £1500 for the half year, allowing absolutely nothing for depreciation. In all the circumstances of the present state of affairs, therefore, it is not to be wondered at that there was—temporarily, no doubt—a decreased gas consumption.

However, the writer found that there was a splendid market here for gas cookers, grillers, &c., if pushed by a good firm; also for gas fittings and burners, as the Corporation are not going in opposition to private traders. When the reconstruction scheme is entirely finished, and the gas undertaking is well established, there certainly need be no fear of Mr. Hungerford's department not going well ahead.

Lyttelton.

Lyttelton, with a population of 4000, is the chief sea port of the Canterbury land district. The harbour, having an enclosed water area of about 100 acres, is surrounded by rugged mountains over 2000 feet high. It is the port for the City of Christchurch, being connected to it by railway—and unfortunately by a tunnel one mile and one-fifth in length, and, the writer should think, the worst ventilated in the whole world.

A small gas-works nestles under the cliff facing the harbour. There are two little retort-houses, and the usual accompanying gas plant. Lime and oxide are used in alternate tiers in the four small purifiers. Gas is stored in two holders. The annual make is 9½ millions. The price of gas is 10s. for lighting, and 6s. 6d. for cooking; and gas cookers and stoves are used in a small but increasing way. The streets are lighted by incandescent gas-burners.

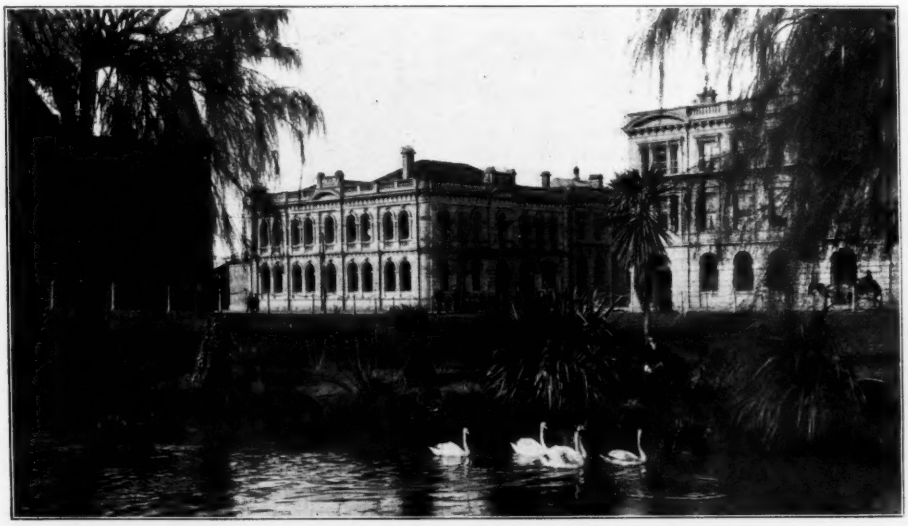
Christchurch.

This capital city of the Canterbury District, with a population of nearly 70,000, appealed to the writer as the nearest approach to an English cathedral city. It originated in 1849 from the Canterbury Association, which, with the Archbishop of Canterbury at its head, purchased over two million acres of land in the district for colonization by Church of England emigrants. The great scheme, however, was not a success; but it established English traditions here, while Dunedin is more Scotch, and Nelson more particularly Welsh.

The writer had just arrived at the gas-works (which belong to and were established in the year 1863 by the Christchurch Gas, Coal, and Coke Company, Limited), when a 20 H.P. motor car, with Mr. Robert English driving, entered the gate. (See Photograph No. 92.) Everybody who knows Mr. English will be pleased to hear that he is as enthusiastic and as busy as ever, with hardly a moment to spare. After the Old Country had been talked over, the conversation turned on his work. Mr. English is not only the Engineer and Manager of the gas-works, but is interested with his Directors in many subsidiary and allied branches of trade, which is sound business in a Colonial town like this. The Gas Company are also general fire-brick manufacturers, and the writer had the opportunity of inspecting some fire-clay just arrived from their mine, and of seeing in process of manufacture their bricks, blocks, and terra-cotta work, such as ornamental chimneys and glazed fountains. Their brick-works plant is a complete one; and the fire-clay material was equal to that of any English production. The manufacture of forks for incandescent burners proved a great success, as well as the making of all kinds of gas cookers, grills, meat safes, &c. Coal, also, has been found within a few miles of Christchurch; and Mr. English is interested in its development.

Prior to his arrival in the Colonies, Mr. English had held important positions with the Gaslight and Coke Company and the South Suburban Gas Company, and had taken an important part in many matters of chemical research and parliamentary consideration of Bills. He has now almost entirely reconstructed his present gas-works, and was chosen by the Corporation of Dunedin (previously referred to) as Consulting Engineer for the reconstruction and extension of the gas-works there.

A walk through the three retort-houses showed that everything was carefully designed and arranged so as to get the best results. The new retort-house (Photograph No. 93) is a handsome building of the stage-floor type. It will be equipped with Mr. English's regenerator settings and furnaces, adapted for being worked by the De Brouwer projector and pushing machines, together with hot-coke conveyor, coke tanks, and screens, supplied by Messrs. W. J. Jenkins and Co. The adjacent coal-store holds 3000 tons,



Photograph No. 95.—The Gas Company's Offices and Show-Rooms—the Centre Building.

and is fitted with elevator and conveyor and crusher. Taken altogether, the installation will soon play havoc with the high rate of wages paid to stokers and yard-men, and will effect large savings. The projecting annexe (seen in Photograph No. 93) contains the mess-rooms and baths.

There are two batteries of Walker's water-cooled condensers, and two of Waller's exhausters, which are nicely arranged and the "show" place expected in a gas-works. Following on is a one-million "Standard" washer, and eight purifier boxes, 30 feet by 20 feet, filled with oxide.

The four gasholders contain about 1,000,000 cubic feet, which is the maximum daily make of the works, the yearly output of which is 245 millions. The largest gasholder (of 450,000 cubic feet capacity) is shown in Photograph No. 94.

The blue water-gas plant, built to Mr. English's designs by the Economical Gas Apparatus Construction Company, is regularly used, and can produce 300,000 cubic feet of gas per day.

Turning to the bye-products, liquid and anhydrous ammonia are made, as it was found that there was little market for sulphate of ammonia; but owing to the large number of freezing works, there is a good demand for the former products.

There is a machine shop, which also does a large amount of sheet-metal work for orders in connection with cooking utensils, &c.; and the mechanical part of the mechanics' shop is ample and sufficient to repair any sort of machinery. In addition, all the gas-lamps are made at the works; and lamps are also sold to other towns.

After inspecting everything in the works, Mr. English remarked: "The gas engineers in England think we are a country-fied, sheep-farming lot, who don't know what's going on and are out of date. Now you have been here, what do you think?" To which the writer could only reply that it would do a lot of English gas managers good to come out here and see the splendid works, magnificent management, and business-like methods—the outcome of a broad-minded policy.

High-Pressure Distribution.

Mr. English kindly placed his motor at the writer's disposal and took him round the city and suburbs. There is a high-pressure main, 10 inches in diameter and 4½ miles in length, which starts from the works and feeds all the other mains. It is at 20 inches pressure, and on the other mains are placed governors fixed at 30-10ths, so that directly any part of the consumers' main falls below this, the governor opens and the deficiency is made up. This plan has given every satisfaction and keeps the incandescent burners in the best of condition. The "boosting" plant consists of a De Laval turbine-engine of 10 B.H.P., connected direct to a Sturtevant blower; and the arrangement appears to work well.

The incandescent lighting, both in the houses and the streets, is certainly a striking feature of the place. All lamps inside or outside public buildings, hotels, or shops are attended to gratis, new mantles are put on, and the globes all cleaned. The writer has never seen a town where the private shop-lamps are so clean and well kept.

A Fine Show-Room.

The offices and show-rooms in the city are centred in one magnificent building, seen in Photograph No. 95. The Company have done the correct thing. All classes of fittings for lighting and appliances of all description are kept here. The entrance leading to the ground floor show-room is fitted with all the latest fittings in the market from England, Germany, and America. Gas cookers, fires, hot-water heaters, and the like, are all in operation. On one side of this huge room, which runs the full width and length of the building, is a long desk on which all business concerning accounts and goods is transacted. The customer is, therefore, obliged to be brought in direct contact with the latest examples of gas-fittings, &c. The lamps are fitted with all kinds of electric, pneumatic, and spring lighters to serve the purpose of the electric switch or button. The board-room is equipped with the electric light and with gas, so that the Directors can be shown and compare any design of lamp for either illuminant. Upstairs, a large store of wholesale parts of every variety is kept in splendid order. Mantles are burnt and burners are adjusted. Outside in the yard are the meter-repairing shops and plumbers' and gas-fitters' benches, tubes, and heavy goods' stores.

The most is also made of exhibitions; and Photograph No. 96 (taken by gas light) shows the Gas Company's exhibit at the Christchurch Exhibition, which was held last year.

A word may perhaps be added in regard to the water supply of Christchurch. There are no reservoirs for the supply of the town, but everybody bores for water. Each house has its own well—some using hand pumps and some windmills. In the gas-works is an artesian well of 3-inch bore to a depth of 360 feet, with a rise of water equal to 35 feet.

In conclusion, the writer's thanks are due to Mr. English for his kindness in giving him all the information and some of the interesting photographs contained in this article.

Photograph No. 96.—The Gas Company's Exhibit at the Christchurch Exhibition, 1907. Photograph taken by Gas Light.

PUSHING GAS IN SOUTH AFRICA.

In the course of a letter from Port Elizabeth, enclosing the photograph which is here reproduced, Mr. William Arnott, the Manager of the South African Lighting Association, Limited, explains that it is a picture he took of the men going out in the morning with the Association's carts loaded with gas-stoves.

Mr. Arnott says: They make a fine advertisement for us as they go through the streets, with "Do you Use a Gas-Range?" "S.A.L.A." is well known here; and we do our best to always keep it to the front in every way possible. All our roofs are whitewashed, and "S.A.L.A." is painted on in black letters 2 feet thick and the length of the side of the roof; so that you can always see our place from all parts of the town. We also keep white our condensers (which we screen from the sun), and the washer-scrubber and purifiers. The latter we keep a roof over. To give you some idea of the cost of railage here, it costs 21s. a ton to send coal from Port Elizabeth to our works at Grahamstown, only a distance of 100 miles; the same coal coming out from England, some 7000 miles, for 11s. 6d. per ton. Tar costs 1s. 1d. per gallon to send it from here to Johannesburg. So we have to work under somewhat disadvantageous circumstances.

TECHNOLOGY OF DESSAU VERTICAL RETORTS.

III.

By Thomas Holgate, M.Inst.C.E., F.C.S.

The general agreement of the results obtained in the tests of May and June last is an encouragement to attempt an elucidation of several subsidiary matters revealed by this study. From what has already been said, ideal water gas—that is, equal volumes of hydrogen and carbon monoxide—should have the following relations in calorific power per cubic foot :—

Constituent of Water Gas.	Gross. B.Th.U.	Net. B.Th.U.	Difference due to Condensation.	
			B.Th.U.	Per Cent. on Gross.
Hydrogen	344	288	56	16·28
Carbon monoxide	342	342	Nil	Nil
Average	343	315	28	8·16

The change in percentages of hydrogen and carbon monoxide will only alter the net calorific power of the mixture, and not the gross; and as all the difference due to the condensation of steam is from the hydrogen, the percentage of that ingredient can be ascertained by dividing the difference per cubic foot by 56 and multiplying by 100. Stated as a percentage in the last column, the difference for hydrogen is $\frac{56 \times 100}{344} = 16{\cdot}28$, and ideal water gas 8·16, which correspond with the customary 10 and 9 per cent. for coal gas and carburetted water gas respectively. Applying these elementary truths to the case before us, we find in the Zurich returns a near approach to these relations; while in those of Mariendorf they are less normal on one side, and in those of Dessau still less normal on the other.

Table VI.—*Showing Relationship of Calorific Powers per Cubic Foot of Mixed Gas.*

—	Dessau.	Zurich.	Mariendorf.	Dessau Recalculated.	Line No.
Increased make per ton during steaming, cubic feet . . .	421	1,640	2,410	421	1
Increased gross calorific power per ton, B.Th.U.	160,844	554,640	746,970	158,077	2
Increased gross calorific power per cubic foot, B.Th.U. . .	382	338·2	310	374·5	3
Increased net calorific power per ton, B.Th.U.	135,163	496,012	677,472	142,585	4
Increased net calorific power per cubic foot, B.Th.U.	321	302·45	281	338·7	5
Increased difference of calorific power per ton, B.Th.U. . .	25,681	58,628	69,498	15,492	6
Increased difference of calorific power per cubic foot, B.Th.U.	61	35·75	29	35·8	7
Difference as a percentage on gross, per cent.	15·97	10·5	9·35	9·56	8
Ratio of line 2 to line 6, as in Table II.	6·26	9·46	10·7	10·4	9

The divergence of results given in the first column of the above table was so considerable that the writer tried to trace the cause of it if possible. He finds the most serious differences are mitigated by a recalculation from the experimental data in the appendix to the British report. The fourth column in the table embodies the result of these calculations, which changes are brought about by using the exact figures for the gross and net calorific powers, instead of the round figures given in the body of the report. The whole of the figures in the table are of significance, and must be discussed line by line. The first one has so far been assumed to be water gas—*i.e.*, hydrogen and carbon monoxide in various proportions. But as a matter of fact there is a possibility that some other combustible gas may be involved therein, although, judging by the analyses made of gases taken at Dessau, there is no clear evidence thereof. For we know that at Zurich and Mariendorf the temperatures of the oven were raised prior to the change over from dry distillation pure and simple. Thus the dry distillation being thereby affected, and also in a contrary direction, by the lowering of the temperature of the retort internally, due to previous steam admission, it is likely the rate of transfer of heat from oven to coal would be altered, and the hydrocarbons from the coal changed either in quantity or composition. Further, we do not know that the purified gas at Zurich and Mariendorf was as low in nitrogen or carbon dioxide as at Dessau.

Disregarding these considerations for the moment, we employ the inferred increased make per ton to find what was the calorific power of the assumed water gas. Dividing line 2 by line 1, we obtain line 3. Here the figures for Zurich very nearly approach the ideal of 343; and it only requires the supposition of about 2 per cent. of incombustibles to account for the difference between the former and the latter—namely, 4·8 B.Th.U. In fact, the difference is so slight as to be within the range of experimental error, and at the same time to confirm the view that only water gas enters into the question. But Mariendorf shows a falling away of 33 (from 343 to 310), which can only be explained by assuming an improbable percentage of inert constituents, or more likely an error in the first line or the other data from which the calculations start. When it is remembered that we are dealing with differences, it at once becomes obvious that slight discrepancies in the figures for gross or net calorific power will make a large error in the difference figure. This will be understood by reference to the figures for Dessau, where the importance is accentuated by the small quantity of water gas made. Even with the recalculated values, Dessau shows nearly as great a disparity as Mariendorf, only on the other side; for it shows gross 374·5, or 31·5 above normality. As will be shown later, some uncertainties exist about the Dessau calorific powers of the mixed gases; and they are probably of the kind sufficient to account for the disparities in the water gas both at Mariendorf and Dessau. Line 4 divided by line 1 gives on line 5 the net calorific power per cubic foot. Zurich is in conformity with a mixture of hydrogen and carbon monoxide, but Mariendorf is lower than it would be if all were hydrogen; while Dessau in the uncorrected figures is 321, or 6 higher than ideal water gas, and in column 4 it is higher still.

The figures just given in their departure from normality are linked with the gross figures; and the same explanation applies.

Line 7 shows Zurich to be within the range of water-gas mixtures. Mariendorf, despite the anomaly of its low gross and net calorific powers, has an almost ideal difference figure—namely, 29—while Dessau has 35·8 (about the same as Zurich). It is important to note the figure 61 in the first column, which is 5 above that for pure hydrogen; and this is almost identical with the observed value for the coal gas. The last-named is given in the body of the report as 61; but by exact calculation it is 61·95—see line 17 of Table IX. This small change is the cause of the relatively large change in Table VI. betwixt the first and fourth columns on line 6. Line 8 is the percentage of line 7 upon line 3, and is the reciprocal of line 9, the ratio made use of in Table II. (*ante*, p. 641). If we apply to line 7 the rule above-mentioned, of dividing by 56 to ascertain the percentage of hydrogen, we obtain the following as the mixtures at the three gas-works :—

Table VII.

—	Dessau (Uncorrected.)	Zurich.	Mariendorf.	Dessau (Corrected.)
Calculated hydrogen in the water gas, per cent. . . .	109	63·84	51·8	64
Inferred carbon monoxide in the water gas, per cent. . .	?	36·16	48·2	36

Zurich and Dessau are within the range of normal water gas; but Mariendorf is better still—it is almost ideal, and perhaps it is shown too good to be true.

If we may be allowed the liberty of calculating the volumes made so as to conform to the ideal gross calorific power of water gas, then the observed volumes will not be seriously modified in the case of Zurich, and order at once appears in the other figures relating thereto. Rather greater change of volume is required to obtain a high degree of concordance at Dessau and Mariendorf; it being a reduction of 23 cubic feet, or 1·4 per cent., at Zurich, a reduction of 232 cubic feet, or 9·6 per cent., at Mariendorf, and an increase of 40 cubic feet, or 9·5 per cent., at Dessau.

Table VIII.—*Adjustment of Water Gas Made, Based upon a Standard Gross Calorific Power.*

—	Dessau (Corrected.)	Zurich.	Mariendorf.	Line No.
Cubic feet of gas per ton due to steaming	461	1617	2178	1
Standard gross calorific power of water gas	343	343	343	2
Standard net calorific power of water gas made	309·3	306·75	311	3
Difference due to condensation—viz., line 2 *minus* line 3	33·7	36·25	32	4
Difference due to condensation—viz., line 4, per cent. on gross	9·82	10·57	9·33	5
Ratio of line 2 to line 4	10·2	9·46	10·75	6
Percentage of hydrogen in the water gas made	60·2	64·75	57·15	7
Inferred percentage of carbon monoxide in the water gas made	39·8	35·25	42·85	8

The composition of the Mariendorf gas is still good, but is here shown more in conformity with the probabilities of the case, and in accord with the gross and net calorific powers and notably of the difference figure, which has now become 32, in lieu of 29. The gas at Zurich is not of so good a quality as at Mariendorf; but the figures, which are very concordant, are not much altered from Tables VI. and VII. The gas at Dessau is examined in detail later, and the deductions relating thereto in Tables VII. and VIII. may be compared therewith.

To ascertain as far as possible the precise share of water gas in the returns from Dessau, the subjoined Table IX. has been compiled by the writer. The day when steaming took place was preceded and followed by a day when no steam was admitted; and

by showing each day distinctly the transition in analysis, calorific and lighting powers are at once followed. The last column is an average of the two days of non-steaming, and takes into account the variation in quantity of gas made on the two days. The duration of the charge varied a little on the first day; but as the second and third days were alike, upon the influence of this factor columns 2 and 3 may be compared. What is notable is the small variation in the three days of any constituent; that of methane on the second day having perhaps the greatest influence upon the final result. The small range in total combustibles is worthy of attention, as is the fact that on the second day unsaturated hydrocarbons were more than on the other two days, when they were exactly equal. Thus it comes about that on the day when the heavier illuminating hydrocarbons are highest the lighting power is lowest; and this apparently must be explained by the decrease of methane on that day.

Calculating from these analyses the gross and net calorific power, one has to decide what value shall be given to the heavier hydrocarbons. Ethylene is inadmissible; and the one that most nearly meets the requirements is propylene. This it does in a quite unexpected degree, although the writer understands that a similar observation has been made where illuminating powers have been connoted with analysis. On the third day the gross calorific power observed and calculated almost perfectly agree, but the difference in the net is 7·4 B.Th.U. (see lines 15, 18, and 22). On the other days the disparity, which is not large, is upon the gross, rather than upon the net; but the singular fact is that in the difference figures the disparity is on every day approximately 8·5. Now the difference figures obtained by calculation from the analysis do appear to show a higher percentage than is usual with coal gas; while the observed figures appear normal. So that we arrive at the conclusion that either the methane or the propylene is accompanied by a minute quantity of some other member of the hydrocarbon series. The calorific power of the gas, excluding for the moment the heavy hydrocarbons, is, according to lines 24 and 25, very uniform for the dry distillation; and when steam is employed, the lowering effect results, according to these tests at Dessau, in the falling off in the percentage of methane. The good agreement in these returns might conceivably have been closer still if a greater number of tests of calorific power had been taken; but, nevertheless, as they stand, they confirm the statement of Mr. Hayman before the Institution of Gas Engineers—that a very uniform gas is obtainable by means of the vertical retort.

TABLE IX.—*Tests of the Average Production of Gas at Dessau.*

—		1st Day.	2nd Day.	3rd Day.	Average of 1st and 3rd Days	Line No.
Average duration of charge, hours		9·71	10	10	9·855	1
Time of steaming in hours		none	1	none	none	2
Cubic feet of gas made in 24 hours		130,690	145,570	118,260	248,950	3
Number of analyses from which average is computed		2	3	2	4	4
Carbon monoxide	CO	5·60	6·87	5·65	5·624	5
Hydrogen	H_2	56·95	57·67	57·80	57·355	6
Methane	CH_4	29·95	28·33	29·95	29·95	7
Unsaturated hydrocarbons		2·90	2·97	2·90	2·90	8
Total combustibles		95·40	95·84	96·30	95·829	9
Oxygen	O_2	0·25	0·30	0·25	0·25	10
Nitrogen	N_2	3·70	2·60	2·15	2·962	11
Carbon dioxide	CO_2	0·70	1·00	1·00	0·843	12
Total incombustibles		4·65	3·90	3·40	4·055	13
Total ascertained		100·05	99·74	99·70	99·884	14
Observed calorific power	gross	596·00	595·66	612·66	603·9	15
	net	534·66	534·66	550·00	541·95	16
	difference	61·33	61·00	62·66	61·95	17
Calculated calorific power	gross	608·3	601·37	613·6	610·880	18
	net	538·0	532·20	542·6	540·244	19
	difference	70·3	69·17	71·0	70·636	20
Contrast between observed and calculated calorific powers	gross	+12·30	+5·71	+0·94	+6·980	21
	net	+ 3·33	−2·46	−7·40	−1·706	22
	difference	+ 8·97	+8·17	+8·34	+8·686	23
Furnished by CO, H_2 and CH_4	gross	536·72	527·5	541·45	539·08	24
	net	471·28	463·33	475·3	473·29	25
Furnished by unsaturated hydrocarbons, calculated as propylene	gross	71·58	73·87	72·15	71·80	26
	net	66·72	68·87	67·3	66·95	27
Average of three tests for illuminating power, in candles		16·403	15·370	16·513	16·453	28

The conclusion of this study indicates that the admission of steam at the close of the period of distillation is without appreciable effect upon the results of dry distillation, except to add thereto a quantity of water gas high in value, whether estimated analytically or from the heating power of the mixed gases. The magnitude of this contribution to the total is capable of being expressed concisely, and may be shown at a glance as follows: Table X. shows in the first line the gain per ton, and in the second and third lines the gains per cent., by steaming; and it is in this

TABLE X.—*Showing Relation between Gain in Volume and Calorific Power.*

—	Dessau.	Zurich.	Mariendorf.	Line No.
Increased volume observed per ton, cubic foot	421	1640	2410	1
Increased volume, per cent.	3·74	13·46	21·14	2
Increased gross calorific power, per cent.	2·3	7·7	11·2	3
Ratio of line 2 to line 3	0·61	0·58	0·53	4
Ratio of the gross calorific power of water gas per cubic foot to that of the undiluted coal gas	0·568	0·58	0·586	5
Ditto, calculated upon a standard basis	0·57	0·58	0·598	6
Corrected volume per ton, required by standard basis	461 cub. ft.	1617 cub. ft.	2178 cub. ft.	7
Corrected increased volume per cent., required by standard basis, that is in lieu of line 2	4·11	13·25	18·72	8

matter that Mariendorf is found to be really at the head. Line 4 shows that there is approximately a constant ratio between gain in volume and gain in calorific power, which, when examined, is none other than an approximation to the ratio between the gross calorific power of ideal water gas and that of the actual coal gas before admixture, given on line 5. The reason why line 4 does not entirely coincide with line 5 has already received attention in another way, and is at once set right if the correction as to volume previously assumed be used as the basis of calculation. Line 6 is the counterpart of line 4, differing therefrom to an extent determined by the new percentages of line 8 as against line 2. Line 3 divided by line 8, gives line 6, which is in very close agreement with line 5. It is true this last exercise is that of reasoning in a circle; but it is employed here merely to show what are the magnitudes in errors of observation that are necessary to bring the actual into conformity with the ideal. There appears every reason for believing that calorifically the actual gains are of the order given on line 3 of Table X.

SCIENTIFIC FARMING.

Sulphate of Ammonia Plots at the Scottish National Exhibition.

[COMMUNICATED.]

THIS exhibit, situated to the west of the Old Hall near to the river, and covering an area of about an acre, is intended to demonstrate in a practical way the advantages of using sulphate of ammonia as a nitrogenous agent in the composition of fertilizers or artificial manures, such as are employed now so largely for agricultural and horticultural purposes at home and abroad. Here are to be seen crops of various kinds growing side by side—one treated with a complete manure including sulphate of ammonia, and the other with the same manurial mixture except in so far that sulphate of ammonia is excluded and the whole of the nitrogen is derived from bone. The crops referred to are mangels, swedes, potatoes, perennialized Italian ryegrass, barley, oats, sugar beet, and tobacco. The manures applied per acre were as follows:—

	Potatoes. Cwt.	Mangels. Cwt.	Swedes. Cwt.	Oats. Cwt.	Grass. Cwt.	Barley. Cwt.
Superphosphate	2	2	2	2	2	2
Fermented bone meal	2	2	2	2	2	2
Sulphate of potash	1½	1½	1	1	1	1
Sulphate of ammonia	1½	1½	1	1	1	1
Carbonate of magnesia	¾	¾	—	—	—	—
Agricultural salt	—	5	—	—	—	—
Ground caustic lime	5	5	5	5	5	5

Ten days before sowing each crop, the 5 cwt. of ground caustic lime per acre was applied and worked in. This system of using lime annually for all crops was introduced to agriculture about fifteen years ago, by the results of the Dalmeny research station; and the practice is rapidly becoming universal.

Besides the usual agricultural experimental plots, there are four drills of varieties of beet, and over a hundred tobacco plants, both of which represent industries, which, if properly encouraged, are considered to have a bright future in Scotland. As illustrating the progress of the beet in the making of sugar, it may be mentioned that forty years ago there were in Greenock eighteen factories for manufacturing cane sugar from the British West Indies, while now there are only two—Germany monopolizing the greater part of the sugar supply by growing sugar beet. The tobacco plants (smoking varieties) were all presented by Lord Dunraven from his beautiful seat, Adare Manor, co. Limerick. They were planted on July 1—over a fortnight late. No farmyard manure was used, but a special mixture containing 15 per cent. phosphates, 5 per cent. ammonia, and 10 per cent. potash (sulphates), free from chlorides. The mixture was applied before planting. Lord Rosebery presented the potatoes and "Dalmeny White Oats" from his experimental station at the Home Farm,

Dalmeny; while the ryegrass, mangels, swedes, and barley are all new varieties from Messrs. Garton, the great hybridizers.

The total production of sulphate of ammonia in Great Britain is 316,000 tons; and of this quantity 100,000 tons are produced in Scotland. Of the total produced, 230,000 tons are exported to foreign parts—Japan, Spain, United States, and Java taking large quantities; the home consumption being comparatively small. It is a mysterious fact that our home farmers are using imported guanos, mainly because of their ammonia compounds, which are costing 17s. 6d. per unit of ammonia, while they are allowing the foreigners to take away our home-made ammonia at about 10s. per unit. It is safe to say that no other industry in the world is (or could be) conducted on such lines—viz., sending out of the country at 10s. per unit a valuable constituent which they replace from abroad at 17s. 6d. per unit.

To encourage a more liberal use of this fertilizer in Great Britain, the Sulphate of Ammonia Committee, composed of the principal manufacturers, is (as your readers are aware) an organization to bring before agriculturists and others its virtues and advantages; and good work has been done, and is being done, to further its use, and considerable economic advantages have accrued not only to the users but also to the country generally by the more liberal use of this agent in agriculture and for horticultural purposes.

Until within comparatively recent years, soils were regarded as practically inanimate masses; and plants were fed by their direct absorption of manurial bodies added to the soil, or bone and other similar material was acted on and made available by the acid juices from plant roots or by the carbonic acid of the air. These doctrines were shown by M'Alpine and Hunter to be untenable; and it was they who created the New Soil Science, which goes to prove that "a sterile soil must be infertile, and that the groups of advantageous soil organisms are as essential to agriculture as yeast is to the brewer or the distiller" (see "Chambers's Encyclopædia" on "Soils" and on "Manures" by Hunter). The experimental station on Lord Rosebery's estate at Dalmeny was started about fifteen years ago to prove or disprove the doctrines enunciated by Hunter; and the New Soil Science has, as the result, become universally accepted, although it is not so fully practised as it should be. These demonstration plots are for the purpose of showing what can be done by the rational treatment of the advantageous groups of soil organisms, which, after all, is the only true science of soils—a science which has proved that inoculation by "Nitragin" or "Nitro-Bacterine" is in practically every case useless and meaningless.

The plots at the exhibition have been visited by many of the principal agriculturists, proprietors, and agricultural scientists of Scotland, England, and Ireland; while not a few representative agriculturists from our Colonies and other countries have inspected the station, which has proved so successful and educative that there is a probability of it being retained as a permanency. Nobody at all interested in the matter should leave the exhibition without inspecting the plots.

RAILWAYS AND PROFIT-SHARING.

[COMMUNICATED.]

"PERHAPS the ideal way out of all present railway difficulties would be profit-sharing on the plan adopted by Sir George Livesey's gas companies, which has proved very successful in that industry." This is the concluding sentence in an article entitled "Discharged"—an ominous development on railway depression—by W. S. Stevens, in the "Evening News." That the railway companies should adopt the system of co-partnership, as at present applied to several of the leading gas companies, has often been suggested and discussed; but it would appear that, in the opinion of railway officials, their methods of working do not lend themselves to the easy application of the system.

Co-partnership with employees is essentially a completion of the sliding-scale system. The sliding-scale must of necessity be considered incomplete unless it has been applied to the three parties—the shareholders, the consumers (or the customers), and the employees. Directors of gas companies are showing hopeful signs of full concordance with this belief. Were the railway companies to adopt the complete system of the sliding-scale, the dividend would presumably be based on the rates charged to traders for the conveyance of goods, and also on the fares charged to passengers. This having once been agreed upon, it would be a simple matter to regulate the bonus of the employees. The exact method by which the sliding-scale could be introduced must be left to those fully conversant with railway matters; but that it could be introduced on a businesslike and proper basis is, and will continue to be, believed by many—in any case until it has been proved to be otherwise. Which of the railway companies will be enterprising enough to institute some practical scheme of a similar nature to that so successfully applied to Sir George Livesey's gas companies and several others?

NEW SHOW-ROOMS AT DARLINGTON.

BY the kindness of Mr. Frank P. Tarratt, the Engineer and Manager of the Darlington Gas-Works, we are able to reproduce to-day a photograph of the exterior of a handsome new showroom which the Corporation have recently opened in the town, for the convenience of present and prospective consumers.

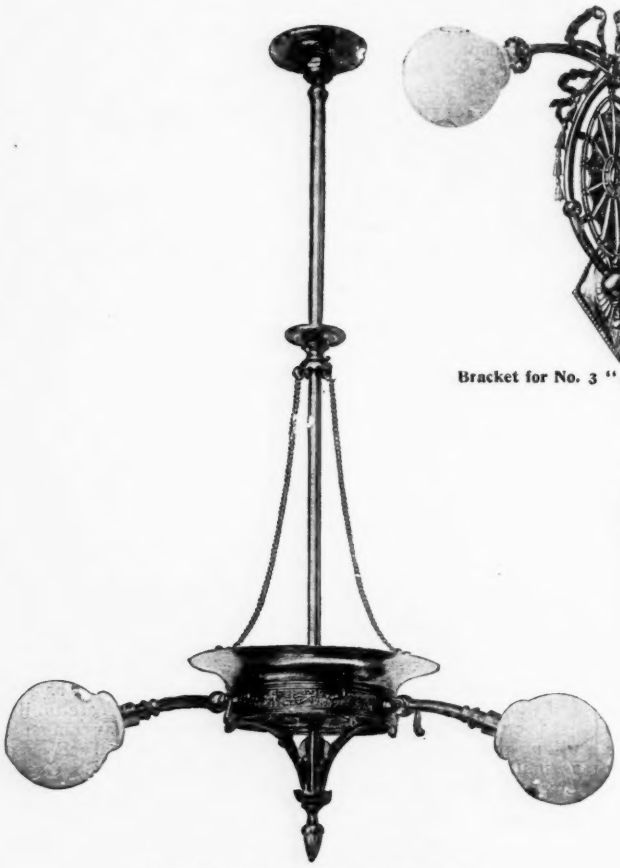
The possession of such excellent facilities as are here indicated for displaying the latest and most efficient appliances for the utilization of gas for the many purposes to which it is so eminently suited, cannot fail to be of substantial benefit to the revenue of the department.

A new form of collier for the trade between the Tyne and the Thames has just been built, to the order of the Wandsworth and Putney Gaslight and Coke Company, by Messrs. W. Dobson and Co., with topside tanks, in addition to the usual double-bottom tanks. Vessels of this type have lately been built for the Canadian and Australian coal trades; but the *Wandle* is the first of the kind to be introduced into our own coasting coal trade. It is claimed that the topside tanks will be particularly suitable to a vessel which has to make regular voyages from London to the North in ballast. The vessel is designed to carry 1250 tons on a light draught; and it will be able to make the voyage under the bridges right up to Wandsworth.

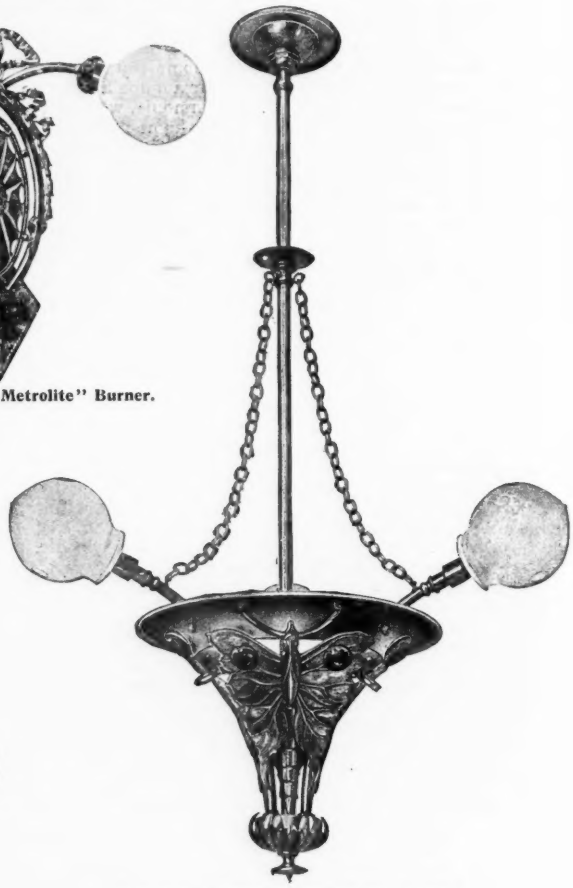
EVERED AND COMPANY'S NEW GAS-FITTINGS.

Some Special Designs for the "Metrolite" Burner.

Bracket for No. 3 "Metrolite" Burner.

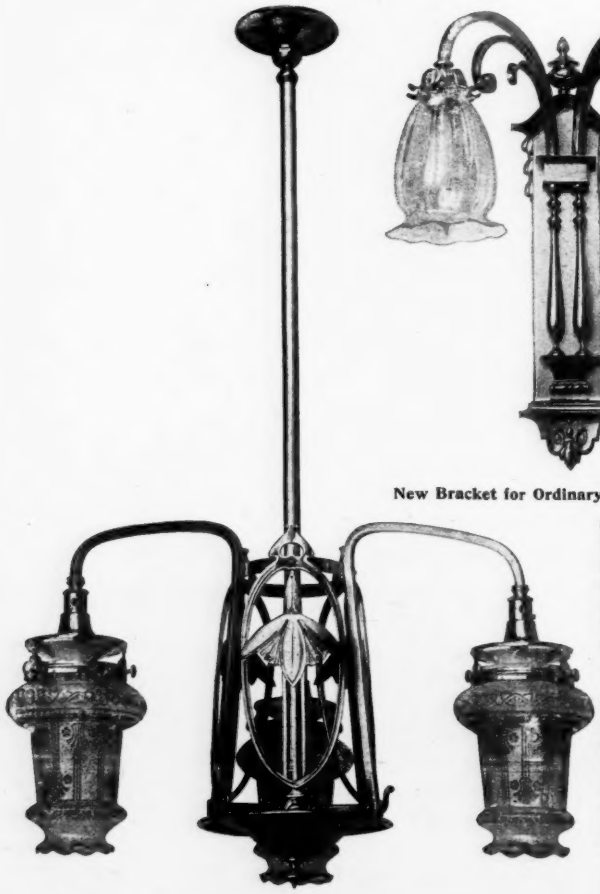


"Metrolite" Burner Pendant (No. 8675).



"Metrolite" Burner Pendant (No. 8670).

New Bracket for Ordinary Inverted Lights.



A Sample Design of Pendant for Ordinary Inverted Burners.

A VISIT to the well-stocked London show-rooms of Messrs. Evered and Co., Limited, at 27–35, Drury Lane, is always a pleasure. The immense collection of gas-fittings, from small plain brackets to the heavy handsome creations intended for the lighting and decoration of large interiors, speaks for itself. In construction, finish, and character—whether plain or ornamental—the fittings tell of high-class workmanship, and of careful design to meet the variety of requirement and taste in these matters, which has to be catered for.

We asked to see some of the new designs and any special novelties. The new designs, it is found, cover so much ground that it is useless attempting description. But as to novelty, that which chiefly appeals to us is discovered in the special fittings that have been made by the firm for the new "Metrolite" gas-burners, patented by Messrs. Dunphy and Tysoe. These burners are known to most of our readers by previous description. But let us recall to mind that all parts of the burners inside the globes are made of fireproof porcelain; that the three burners composing the series are made at such angles—upward, right, and downward—that no metal work of burner or fitting comes into the path of the products of combustion; that notwithstanding the angle, the shape of the burners allows the mantles always to be suspended vertically; that the globe is of lemon shape; and that the flange at the rear end of the fireproof porcelain part is so grooved that the globe simply screws on to it. The illuminating duty of the burners is about 30 candles per $1\frac{1}{2}$ cubic feet of gas consumed.

The fittings that Messrs. Evered and Co. have specially made for these burners are of exquisite design, and are constructed to give the best effect to the different angled burners, though let it be said that a small brass ball-adaptor can also be used for the burners in cases where new fittings are not required. It cannot be helped, but the fact remains, that the fittings and angled burners give as near an approach to electric fittings as can be imagined. The highly ornate brackets are particularly to our liking. They are finished in ormolu, silver antique, and copper antique, of the various periods—more especially the Adam and the Empire. Some sample illustrations will complete what has been very inadequately expressed here. Turning to the special pendants for the "Metrolite" burners, there is a good selection

from which to make choice. Two or three may be described. These are not only attractive, but interesting in character. Take the one numbered 8673 for three lights. It can be had in various finishes; but the one inspected has a triangular ormolu finished band, with Adam design worked upon it. Chains gracefully hang from halfway up the down rod. Another design (No. 8670) for those who want something still more striking is a pendant for three lights, the branches for which rise out of a metal basket at the base. Round this basket are three castings representing a large butterfly design, with emerald stones in the wings. Ornamental chains run from the branches carrying the burners to a point well up the central rod. The one inspected was finished in silver antique; but the same pattern may be had in polished brass or in other finishes. A simpler design, yet with its simplicity handsome, is No. 8675. This has at the bottom of the centre rod an inverted corona band from which the burner arms branch out; and further ornament is imparted by chains running from the top of the corona to half way up the central tube. This pendant is very neat and compact in appearance. It is finished in ormolu or silver antique. Of course, the facts that the fittings do not get black, and that the light is perfectly shadowless, are very considerable advantages.

Having inspected these special pendants, we wander among an amazing display of other fittings (brackets, pendants, hall lights, and so forth) mostly for inverted burners large and small, and few for upright burners—in numerous designs and style of finish. Shade lights are among them—in fact, whatever the purpose, whatever the taste in style, here every want can be gratified.

LIGHTING FITTINGS DISPLAY.

New Inverted Incandescent Gas-Lamp Company's Show-Rooms.

THERE is art in making an effective display of any class of goods, and especially of gas-lighting fittings. Many are the show-rooms of gas-fitting makers of which inspection has been made; and, in some of them, it must be said there has been seen quite a bewildering forest of pendants and other fittings depending from the ceiling, without any attempt whatever at classification for the convenience of inspection by the visitor. Plain fittings are mixed with the most ornate productions of the metal-worker's art, as though purposely done to emphasize the plainness of the one, and the richness of the other. Fittings for vertical incandescent burners are mixed confusedly with fittings for the large or small forms of inverted burners; and those for the two latter species of burner are also mingled in a manner that does not lend itself to ready choice. Lamps for outdoor use, too, are found scattered among those for indoor use. In like manner, fittings of different metals and finishes are put up without pretence at any orderly arrangement. It is a pity; but the remedy, given ample space, is not beyond reach.

These points are borne more forcibly upon one by a visit to the new show-room and offices of the New Inverted Incandescent Gas-Lamp Company, Limited, at No. 19, Farringdon Avenue, E.C. The old show-rooms had become altogether inadequate for the variety of inverted burners and fittings the Company have now to produce and show. As the new show-room is inspected, covering as it does an area of 77 ft. by 26 ft., with attendants' offices in the rear, thoughts turn back to only some seven years ago, when the then new inverted burner was exhibited in a comparatively small show-room on the opposite side of the thoroughfare. Subsequently a more extensive place was taken on the other side; and now that show-room and other accommodation have had to be superseded, and converted into storage place only, while still larger neighbouring premises have had to be taken for display purposes, the transaction of the commercial part of the flourishing business, and for packing and other work connected with distribution. Still, in addition, reserve stores have had to be provided in Birmingham. The signification in the shape of success that all this represents is apparent; and we are among those who are indeed glad to see that the pioneers in this country of the highly popular—and increasingly so—system of inverted gas-lighting now reap such a measure of reward, despite keen competition.

However, we are in the new show-room; and, unaided, one readily detects the thought and system that have been brought to bear upon its equipment. The lamps, fittings, and glassware have all been assembled in groups, subdivided by character in respect of metal, finish, and purpose. That is the root principle followed in the scheme of display; and excellent for discrimination and selection it is found. As inspection is made, the thought comes to mind that the inverted gas-burner has been prolific in enlarging the scope for artistic work in fittings and in bringing out latent ingenuity. The variety defies separate description in the compass of anything short of a bulky catalogue. The groups of wall fittings and those depending from the ceiling are so spaced that each component in a group can have its features inspected without hindrance by the too close proximity of neighbours. Here we have fixed on one wall a group of oxidized silver brackets for ordinary inverted burners—all fitted up complete. The selection shows some charming designs. The eye wanders next to a group of oxidized copper fittings, suitable in design for any purpose. If brass is preferred, then here is a long range of brass brackets, so fitted that an individual view can be obtained. These lead up to a group of old gold fittings for the drawing-room, all furnished with the bijou burner. Chaste and exquisite are the designs—fit participants in the highest scheme of refinement in appointment. A range of copper fittings follows; then a group of polished brass fittings for the bijou burners. Similarly are grouped along the ceiling pendants for single and cluster lighting, with the variety of inverted burners that the Company now supply. We stop a few minutes to inspect the wrought-iron pendants, and a range of outdoor inverted burner lamps, starting with a single mantle, and ascending to a lamp containing five. A cluster of three bijou separately enclosed burners under one reflector head makes a very neat fitting. While looking at this, attention is directed to the square white painted supporting columns in the show-room, on which are fixed brackets in a manner and position that admit of close investigation. Two or three isolated show-cases are ranged down the centre of the room; and these are reserved for some of the smaller artistic fittings. Glancing again at the pendant fittings, it is remarked that even the sample silk and other shades are so grouped on pendants that comparison can be readily effected by the eye. In short, there are here the samples of fittings suitable for any position or purpose—from the kitchen to the drawing-room—all displayed with system and effect that are very useful to the purchasers. The wonderful strides that have been made in fittings production, solely through the inverted gas-burner, are duly impressed by what is here seen.

We have so far abstained from specially mentioning a couple of novelties that are striking in their merit, from both the artistic and utilitarian point of view. These are the new "Nico-Intense" burners and the "Nico" desk light. Regarding the former, it is the latest thing in burner and style that the Company have to offer; and like all its predecessors, it stands for a fresh increment of advance. From the first with the Company, no burner has ever been brought out just for the sake of calling it new; it has always had for its support in favourable consideration some increase of efficiency. The "Nico-Intense" burner is a worthy addition to the long line of predecessors. It is on the self-intensifying principle. In the large size, it is made for burning 4 cubic feet of gas an hour; and it renders an illuminating duty equal to 115 candles—a little more and the efficiency would be 30 candles per cubic foot of gas consumed. This lamp is made with a white porcelain body, with gold or green empire decoration. It is a burner that gratifies the eye externally as well as on account of its efficiency. There need be no darkened metal or shabby exterior with a lamp so constructed, as it will be one of the simplest things in the world to keep it perpetually clean. But striking, too, is the lamp—under the same name, and incorporating the same principles and style—which is intermediate in size between the one described and the bijou form. There is a big field in domestic lighting for a lamp about midway between the full-size inverted and the old, but much in request, bijou; and this particular one with a consumption of only 2½ cubic feet of gas will give an account of itself to the extent of 70 candles—the efficiency thus being about on a level with that of the larger form. This, however, is made in polished brass, white enamel, or black bronze finishes. As to the desk reflector light. This is on a stand so weighed at the bottom, and with short spreading feet, that it cannot be overturned. At the top of the stand is a weighted swing arm, at the upper curved end of which is a bijou burner, covered by a conical reflector. Now the beauty of this desk light for workers is that the arm can be turned round in any position, or can be tilted to any angle, so that the light from the burner is directed to any desired position on to the work upon which one may be engaged, and yet the worker's eyes are protected from all irritating light influences. It is such a simple fitment that nothing can go wrong with it; it is so useful that it is bound to have a big adoption for several purposes. For instance, one is going to St. Mark's Church, Hanwell, for use as a pulpit light. Of this, the occupants of the pulpit may rest assured—the light will not disappear just as they are reaching some of the most eloquent periods in their discourses.

In one part of the show-room are, at a suitable height, stepped shelves on which are displayed glassware for inverted burners. Here the same systematic arrangement has been followed. The globes for the ordinary size inverted burners, are arranged in sets, with style classification in respect of plain, frosted, or tinted glass. Legion is the variety of patterns of inverted glassware, and here may be seen samples of the best; but, though extensive in number, there are no two patterns alike. The same may be said of the bijou glassware. But all of the numerous patterns represent enormous stocks. Of some of them, so popular is the demand, thousands of each have to be stocked at a time.

Wherever one looks in the show-room, there is much to be admired. It is a striking answer to the claim of the electricians to monopoly in artistic lighting fittings. A visit is also made to the packing and store room below, occupying a like ground area. Great bins of inverted burners and mantles of all kinds are seen here; and, in passing, a large supply is pointed out of the types required in train lighting, in which there has been an extraordinary extension of business. Passing up to the offices above the show-room, there is again evidence of the activity that tells the outsider, without words, the story of success and expansion. All this fresh change has been effected betimes for the lighting season upon which entry has been made; and we join in the heartiest of congratulations to the Company upon what they have already done, under the supervision of their energetic Managing-Director, Mr. James Bridger.

DAYLIGHT AND ARTIFICIAL LIGHT.

A paper dealing with and contrasting day and artificial light has been contributed by Dr. EDWARD L. NICHOLS, of Cornell University, to the proceedings of the New York Section of the Illuminating Engineering Society. The paper contains a good deal of useful data and information indicating the physical or colour differences between daylight and various forms of artificial luminants, and it was written for the purpose of establishing definite comparisons which might be of service to illuminating engineers.

The author first discusses the several characteristics of daylight considered as illumination. He points out that though the sun distributes light of an essentially continuous spectrum, this is greatly modified by atmospheric absorption—a varying proportion reaching us after selective reflection from minute particles in a turbid atmosphere, from cloud masses, and from the surface of the earth itself. Data for six months (February-August, 1903) are taken from the records of the Astrophysical Observatory of the Smithsonian Institution, and those for a zenith sun give the percentages of light transmitted from varying wave-lengths.

Wave-Length in c.m.	Percentage Transmitted.
$\cdot 80 \times 10^{-4}$	80·1
·70	75·6
·60	68·2
·50	62·4
·45	55·3
·40	47·5

It will be seen that the violet end of the sun's spectrum is reduced to less than one-half by passing through our atmosphere, while the red end loses less than 25 per cent. of its initial intensity. The ultra-violet rays are affected even more strongly; the photometric spectrum of sunlight terminating at a wave-length of about $\cdot 30 \times 10^{-4}$ c.m.

Speaking of daylight with reference to its indirect components, it is pointed out that daylight from the unclouded sky is relatively stronger in the blue and violet than sunlight by greatly varying amounts dependent on the state of the atmosphere.

Dr. Nichols then deals with the differences between light from varying and actual skies and direct sunlight. The theoretical relation for an ideal sky was deduced by Lord Rayleigh from the properties of a turbid medium, the particles suspended in which were small compared with a wave-length of light. This showed that the intensity of the diffused light of any given wave-length in terms of that of the incident sunlight of the same wave-length, varies inversely as the fourth power of the wave-length. The relative intensities of such a sky as compared with sunlight is given graphically in curve R, fig. 1, the ratio of the sky to the sun being

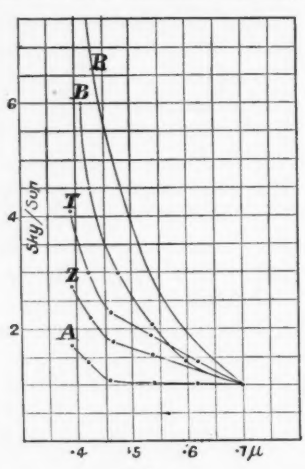


Fig. 1.

taken as unity at a wave-length of ·70. Actual skies, when compared with direct sunlight, rarely approach this ideal relation. They give curves very much nearer to sunlight. Thus B is plotted from the average of measurements made on five different days in March and April, by Bock, at Passau, Bavaria. Summer skies have still less preponderance of blue even in the finest weather, as was shown by Crova in a series of observations extending over two years. Curves T, Z, and A, from measurements made by the author himself last summer at Trafoi (Tyrol), and at Zernez and Andermatt (Switzerland), are typical cases of summer skies.

The author states that an unshaded surface receives sunlight and skylight in varying proportions. The ratio of sunlight to shaded illumination is approximately 15 per cent. Daylight, taken as the illumination of an unshaded surface, differs but slightly in quality from sunlight, since the latter is the dominant factor. Taken, however, as the light illuminating a shaded surface, it is always bluer than sunlight, occasionally with the violet relatively eight or ten times as strong as the red, and ranging from this to light less than twice as blue as sunlight.

Dr. Nichols, looking upon the eye as having been through the ages developed and adapted to the particular stimulus of sunlight, points out that it is the result of evolution, rather than of coincidence, that the maximum of the luminosity curve (L) for the normal eye is in the same region of the spectrum as the maximum of the energy curve (E) of sunlight—see fig. 2.

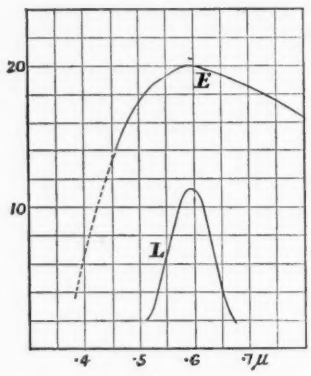


Fig 2.

Since primitive man was not nocturnal in his habits, the range of sensitiveness of his eye is for daytime use; and it is suggested therefore that the acceptance of daylight as an ideal or standard by which to gauge existent illuminants has a sound philosophical basis. The author consequently takes it as a general principle that *the normal stimulus of the eye is diffused daylight and that artificial stimuli which depart widely from it, either as to intensity or quality, are sure to be unsatisfactory and are likely to be injurious.*

Dealing then with the question of intensity, Dr. Nichols indicates the difficulties which at once confront the investigator in his attempt to establish a standard. The range of intensity of ordinary daylight, as between summer and winter, or between noontime in the open air on a fine day when the sky is filled with sunlit cloud masses and a dark overcast day indoors, is considerable. The paper includes a diagram (fig. 3) of curves showing the

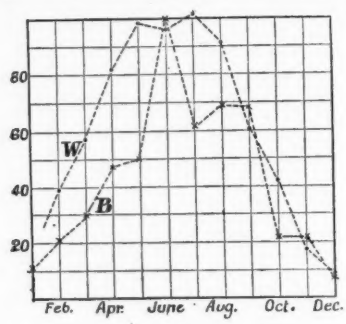


Fig. 3.

results obtained by Weber (W) and Basquin (B) in the determination of the annual variation. A similar diagram (fig. 4) indicates the average range of daylight brightness between 7.30 a.m.

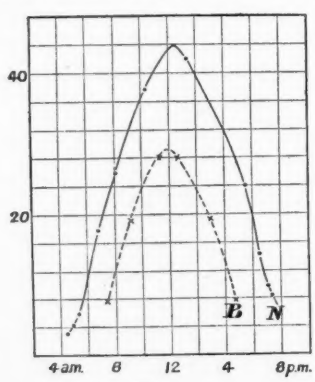


Fig. 4.

and 4.30 p.m. The curve B represents Professor Basquin's results and that marked N data obtained by the author from observations made at Sterzing (Tyrol). The excess of light in the later hours of the day in the case of curve N is attributed to the gradual accumulation of condensed moisture in the atmosphere, which in the shape of sunlit cumulus clouds greatly increased the effect of reflection.

The author further indicates the sudden fluctuations caused by the gathering and dissipation of cloud masses, and gives as an example a variation in brightness from 4 to 1 in the space of two minutes due to this cause. Professor Basquin's data showed an

average brightness for the unclouded sky of 1·5 times that of the overcast type.

Dealing with the human eye, Dr. Nichols points out that this, developed under and adapted by long ages of exposure to daylight, admits of a certain range both as to intensity and quality. The intensity of full daylight—out of doors, but protected from direct sunlight—lies, however, near the upper limit of its power. Bright summer daylight may induce no fatigue, but the addition of reflected light from snow, whitewashed walls, and sometimes water, causes a demand for protection. No one cares to read in direct sunlight. The eye usually adjusts itself within limits to mere brightness, but exposure on sunlit snowfields, at heights of 3000 metres or more above the sea level, involves injury from excess of ultra-violet. We are near the danger limit in this respect also, since the absorption of ultra-violet rays by the atmosphere is only just sufficient at lower levels to protect the eye.

With regard to intensity, the average illumination from the entire sky in July according to Weber reaches about 100,000 hefner metres. H. C. Vogel's measurements at Charlottenburg in 1897 gave a summer maximum of 78,000. Professor Basquin obtained for the month of June 33,000 hefner metres. This was in Chicago; and the lower value was probably due to the less clear sky over a large and smoky city. These values probably represent the upper limits of what the eye endures without any undue fatigue.

Dr. Nichols then discusses the quality and composition of daylight, the study of which is, he says, a matter of spectrophotometric comparison. The investigation of sunlight shows it to be of an exceedingly variable composition. There have been few recorded direct comparisons between sunlight and artificial illuminants, wave-length by wave-length. Crova used for such purposes, as his comparison standard, the Carcel lamp; H. C. Vogel, a petroleum flame; W. H. Pickering, a gas flame; and Else Koettgen, the hefner lamp. Miss Koettgen's measurements may be regarded as typical, and they are referred to a standard concerning which our data are comparatively complete and definite. The curve given in fig. 5 is from her data, but plotted in a modified form,

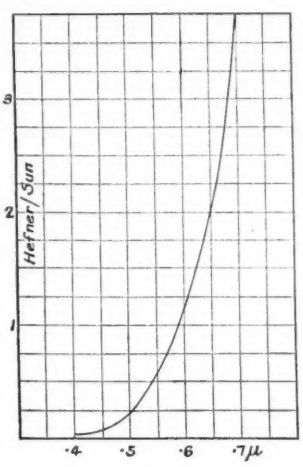


Fig. 5.

so that ordinates represent the quantity $\frac{H}{S} \cdot \frac{S_{\cdot 59}}{H_{\cdot 59}}$ where H is the intensity of the spectrum of the hefner flame for any region, S the corresponding intensity of the spectrum of sunlight, and $\frac{H_{\cdot 59}}{S_{\cdot 59}}$ the ratio of the two spectra for the region of the sodium lines. The curve indicates therefore the relative distribution of intensities in the spectrum of the hefner flame as compared with sunlight where the two spectra are taken as of equal brightness at a wave-length of ·59. It will be seen from the curve that the strength of the violet of wave-length, ·40, in the spectrum of the hefner flame is about $\frac{1}{70}$ of that of sunlight when the two are of equal strength in the extreme red. An acetylene flame makes a much better comparison source, since it is relatively about five times as intense in the violet as the hefner flame. Our knowledge of the quality of the light emitted is equally accurate. Had an acetylene flame been used in Miss Koettgen's work, the strength of the violet would have been about $\frac{1}{14}$ instead of $\frac{1}{70}$ that of sunlight.

The author made in 1907 several comparisons of the red and violet respectively of sunlight with their corresponding wave-lengths in the spectrum of the acetylene flame; and he found that Swiss summer sunlight was relatively weaker in the blue and violet than that measured by Miss Koettgen in Berlin during August, 1893. He gives the average value of the ratio of sunlight to the acetylene flame in violet (wave-length $\cdot 42 \times 10^{-4}$ c.m.) as 5·81, when the two spectra are of equal brightness in the extreme red ($\cdot 725 \times 10^{-4}$ c.m.).

Dr. Nichols made an extended series of spectrophotometric observations during a recent trip on the Continent, and he uses these in his paper for the discussion of the selective modifications occurring in diffuse daylight. The instrument employed was a simple form of Lummer-Brodhun spectrophotometer; the comparison source being a small acetylene flame.

Speaking first of the light from the sky at dawn and after sunset, the author describes this as sunlight diffusely reflected by the upper atmosphere and unmodified by selective reflection from clouds and earth, and he gives a curve indicating the intensity of its spectrum in terms of that of the comparison acetylene flame, wave-length by wave-length. This typical "dawn curve" shows the relative brightness of the violet from the sky to be about twenty times that of the acetylene flame.

After sunrise and with full light at (say) 9 a.m. in summer, the light from the zenith sky is sometimes increased twenty-fold compared with dawn brightness; and a further curve is furnished showing the increased light received. If the dawn curve is replotted, increasing its intensity by multiplying all the ordinates until its red is equal to that of the 9 o'clock or daylight curve, it will be found that while the extremes—that is, the red and violet—of the new curve are practically alike, the central portions do not accord. The discrepancy is greatest in the yellow region, where the intensity of the yellow in the daylight is relatively twice that in the dawn curve. This is attributed by the author to the effect of reflected light (from the brown or yellow soil of the earth and from foliage) upon the colour of the sky.

The influence of sunlit fog, mist, or cloud masses, is quite different and easily distinguished. In this case, there is an increase in the brightness of the longer wave-lengths extending to the extreme red, and not selectively, with a maximum in the yellow, as with earth-reflected light. The presence of the condensed moisture would appear also to produce an extraordinary diminution in the extreme violet.

Dr. Nichols next proceeds to the more practical part of the subject—the comparison of the quality of various artificial light sources with that of daylight. For this purpose, he had to select a standard to represent the latter; and the difficulties to be encountered in doing so have already been indicated. The author had during the six months, February-August, 1907, made some 150 sets of observations, of which 115 were in full daylight. They were made in all the types of weather encountered during the period—although fine weather had more than its fair share of attention. The results are given in a table showing the average intensities of the spectrum of daylight (in terms of that of the acetylene flame) as obtained at stations near the sea level, or at moderate altitudes—these being Algiers, Biskra (Algeria), Naples, Palermo, Vienna, Geneva, in Turkey, Sicily, and at sea; and also at stations among the Tyrolese and Swiss mountains. It will probably be sufficient to give the author's general averages of the data obtained:—

Wave Length in 10^{-4} cm.	Average of the Low-Level Stations.	Average for Switzerland and Tyrol.	Average of all Stations.
·725	5·82	8·80	7·13
·620	10·33	18·05	13·70
·530	15 57	28·45	21·22
·460	22·30	46·00	32·75
·420	27·80	57·35	41·02
·390	31·71	54·10	41·60

Since the determination of the average quality rather than of intensity of daylight is in question, Dr. Nichols reduces the figures of his results to a common basis by giving them all the same value in the region of maximum luminosity at wave-length ·59, in the usual manner. Again omitting the detailed figures of reduced values for the various places already mentioned, the average values for the ratio "Daylight /C_2H_2" are given as under:—

Wave-Length in 10^{-4} c.m.	Lower Stations.	Switzerland and Tyrol.	Average of all Stations.
·725	·490	·420	·450
·620	·866	·859	·865
·590	1·00	1·00	1·00
·530	1·31	1·35	1·34
·460	1·87	2·19	2·07
·420	2·34	2·73	2·59
·390	2·67	2·58	2·63

Having established a standard for daylight, Dr. Nichols points out that all artificial light-sources which have been compared with the acetylene or the hefner lamp may be expressed in terms of daylight, wave-length by wave-length; and he gives data of the ratio to daylight for the spectra of various typical illuminants, as shown in the table appearing on p. 792.

Dr. Nichols groups the artificial light sources under consideration as follows.

Class I.—The old sources which owe their luminosity to incandescent carbon (flames and electric glow lamps).

With regard to the quality of light in this class, candles, oil, and gas-flames are very nearly identical with the hefner flame, though improvements in conditions of combustion are bringing their more modern forms nearer the acetylene flame.

Some of the author's curves are reproduced (fig 6), contrasting a flat-flame petroleum lamp and a gas-flame (Sugg's standard burner) with the hefner (X) and acetylene (C_2H_2) flames.

Dealing with some of the electric glow lamps included in the table given above, it is remarked that the important characteristic of the newer high-efficiency lamps with metal filaments consists in a relative weakness of the red, a slightly increased intensity of the green and yellow, but no preponderance in the blue

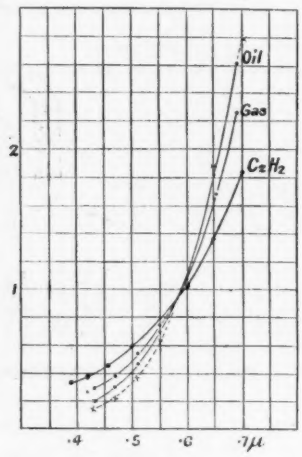


Fig. 6.

TABLE *Showing Various Sources of Light Compared with Average Daylight.*

[Ratio at a wave-length of 0·59 × 10−4 centimetres = 1.]

I.—Hefner Lamp.			II.—Acetylene Lamp.
Wave-Lengths. Centimetres.	Hefner/Sky. "L"	Hefner/Sky "A"	C_2H_2/Sky.
0·700 × 10−4	2·670	2·790	1·847
0·650	1 860	1·890	1·381
0·590	1·000	1·000	1·000
0·550	0·700	0·663	0·785
0·500	0·407	0·380	0·598
0·460	0·251	0·223	0·452
0·420	0·164	0·145	0 368
0·390	0·114	0·114	0·370

III.—Petroleum Flame.		IV.—Gas-Flame.	V.—Glow-Lamp at 108V.
Wave-Lengths. Centimetres.	Oil/Sky.	Gas/Sky.	[Carbon Filament] Carbon/Sky.
0·700 × 10−4	..	..	1·920
0·690	2·650	2·270	..
0·650	1·840	1·695	1·382
0·590	1·000	1·000	1·000
0·550	0·708	0·753	0·770
0·510	0·479	0·560	..
0·500	..	..	0·581
0·470	0·303	0·397	..
0·460	..	..	0·438
0·430	0·202	0·306	..
0·420	..	..	0·353
0·390	..	..	0·351

VI.—Metallized Filament. [108-1·2 V. at 110 V.]			VII.—Tantalum Filament. [At ·09·5 V.]	
Wave-Lengths. Centimetres.	Carbon/CH_2.	Carbon/Sky.	Tantalum/C_2H_2.	Tantalum/Sky.
0·700 × 10−4	1·090	2·020	0·970	1·795
0·650	1·036	1·453	1·001	1·382
0·590	1·000	1·000	1·000	1·000
0·550	0·945	0·742	0·940	0·740
0·500	0·920	0·550	0·825	0·494
0·460	0·790	0·357	0·682	0·309
0·420	0·600	0·221	0·540	0·200

VIII.—Nernst Filament. [At 0·8 Amp.]			IX.—Tungsten Filament. [At 110 V.]	
Wave-Lengths. Centimetres.	Nernst/C_2H_2.	Nernst/Sky.	Tungsten/C_2H_2.	Tungsten/Sky.
0·700 × 10−4	0·910	1·680	0·860	1·590
0·650	0·990	1·365	0·923	1·278
0·590	1·000	1·000	1·000	1·000
0·550	0·955	0·752	0·962	0·755
0·500	0·854	0·510	0·946	0·566
0·460	0·747	0·338	0·935	0·422
0·420	0·600	0·221	0·938	0·347

X.—Welsbach Mantle. [German, 1894.]			XI.—Welsbach Mantle. [American, 1908.]		
Wave-Lengths. Centimetres.	New W/Sky.	Old W/Sky.	Wave-Lengths. Centimetres.	W/C_2H_2.	New W/Sky.
0·670 × 10−4	1·215	1·055	0·700 × 10−4	0·760	1·400
0·650	1·495	1·315	0·650	0·840	1·160
0·590	1·000	1·000	0·590	1·000	1·000
0·550	0·877	0·972	0·550	1·065	0·838
0·510	0·723	0·908	0·500	1·030	0·636
0·470	0·550	0·765	0·460	1·060	0·431
0·430	0·428	0·660	0·420	0·800	0·297

XII.—Magnesium Ribbon. [Burning in Air.]		XIII.—Open Arc Lamp. [10 Amp., 50 V.]	
Wave-Lengths. Centimetres.	Mg/Sky.	Wave-Lengths. Centimetres.	½-Inch Carbons. Arc/Sky.
0·700 × 10−4	1 356	0·700 × 10−4	1·200
0·650	1·148	0·650	1·140
0·590	1·000	0·590	1·000
0·550	1·116	0·550	0·911
0·500	1·470	0·500	0·692
0·460	1·675	0·460	0·576
0·420	2·320	0·425	0·553
		0·390	0·433

and violet, as compared with acetylene. The Tantalum and the Nernst filaments and the so-called "metallized" carbon filament when of the same brightness in the yellow, are much weaker in the violet than the acetylene flame.

The simple form of all the curves, obtained in Class I., indicates that the type of radiation is closely related to that which we receive from the sun, differing from the latter primarily on account of the lower temperatures.

Class II.—Sources of light consisting of incandescent oxides (lime light, zircon light, Welsbach mantle, and burning magnesium).

After referring briefly to the first two lights, Dr. Nichols states that the Welsbach mantle shows very varied qualities, according to its composition, age, and conditions of combustion. Miss Koettgen's researches in Germany, several years ago, revealed the remarkable weakness in the red and the pronounced selective maximum at ·650 (yellow) depicted in the curves reproduced—fig. 7. These show noteworthy changes in distribution

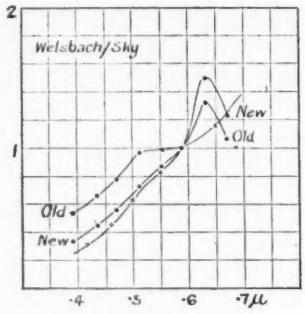


Fig. 7.

of intensity throughout the spectrum, due to age; and this peculiarity is verified by the author. A recent American mantle (Curve X), is included, but is less strikingly selective.

In view of its importance in photography, data and curves of the light from burning magnesium are also given. The features of this illluminant, when its spectral yellow is equal to that of daylight, are a relative increase towards the red, by reason of its lower temperature of incandescence, and also towards the violet because of its luminescence.

Class III.—Light sources with spectra consisting chiefly of a few or many bright lines (flaming arc, mercury arc, vacuum tube light).

As to these, Dr. Nichols knows of no simple or direct way of making a quantitative comparison with daylight.

In the mercury arc, the light comes practically from three narrow regions—two yellow lines, the green line, and the brightest violet at wave-length ·4358; and the author compares the brightness of these lines with the corresponding regions in the spectra of the acetylene flame and of daylight. The ratio for the region of the yellow lines in both cases is taken as unity.

Yellow lines. (·5790-·5769.)		Green line. (·5460.)		Violet line. (·4358.)	
Hg/C_2H_2	Hg/Sky	Hg/C_2H_2	Hg/Sky	Hg/C_2H_2	Hg/Sky
1·000	1·000	3·75	3·00	16·81	7·85

Dr. Nichols states that the light of the ordinary carbon arc lamp partakes of the nature of the first and the third of the three classes, having groups of bright lines superimposed upon a continuous spectrum. Where the carbons are impregnated, the only lines strong enough to appreciably affect the quality of the light are those of the band at wave-length ·425. The intensity of the violet band fluctuates greatly, but the value given (see the above Table) is a fair average for the ordinary self-regulating commercial lamp.

In the summary, the author says again that daylight as to intensity and quality is to be regarded as the normal stimulus of the human eye; but he adds that at its brightest, it represents very nearly the upper limit of intensity at which the eye can work without fatigue and injury. Of the various sources studied, no one approaches identity with daylight as to composition, though the relation of light sources in Class I. to the same is a simple one, easily expressed in graphic form. Those in Class II. show more or less marked selective radiation. The bright line spectra of Class III. cannot be simply compared to daylight.

The speciality of the Anti-Tear Patent Washing Machine Company, of No. 80, Finsbury Pavement, E.C., is (as the name implies) an appliance for laundry purposes; and the only justification for referring to the invention here is its suitability for use with gas as a heating agent. The machine is made of strong galvanized iron; and though we are unable to speak from personal experience as to its efficiency, the instructions for its use show that it is at any rate easy to manipulate. It is not an expensive article; and provided it does its work as thoroughly as is claimed by the Company to be the case, it will be welcomed as an ally by those who are engaged in developing the consumption of gas.

INVESTIGATION OF GASEOUS EXPLOSIONS,

WITH SPECIAL REFERENCE TO TEMPERATURE.

The British Association Report.

(*Concluded from p. 722.*)

EXPLOSION EXPERIMENTS.

If a combustible mixture of gases be fired in a closed vessel impervious to heat, and if sufficient time elapse to allow of the attainment of complete thermal and chemical equilibrium, the internal energy of the products of combustion after the explosion will be equal to the chemical energy before explosion. The latter is capable of accurate measurement. The temperature reached after explosion can be inferred from the pressure, assuming the gaseous laws to hold. The pressure can also be measured without difficulty and with considerable accuracy.

In the study of explosion pressures we have, therefore, a very convenient and simple means of getting the internal energy-function at high temperatures, provided that it is possible to make the necessary corrections for deducing from the pressures observed in a real explosion the pressure reached in an explosion under the ideal circumstances postulated above. Moreover, the gaseous laws on which the temperature estimations are based can themselves be checked, and if necessary corrected, by comparison of the pressures reached by mixtures of the same composition but of different densities. Thus explosion experiments are capable of furnishing a complete account of all the thermal properties of gases at the temperatures reached by combustion—subject always to the possibility of making the corrections referred to above. The difficulty of finding these corrections is, however, very great; and in consequence of the uncertainty which prevails even as to their order of magnitude, the large amount of work which has been done on explosion pressures gives but little definite information as to the specific heats of gases. Nevertheless, it is to the study of explosion pressures that we owe such knowledge as we possess of the energy function at the temperatures which prevail in the gas-engine; and it is to work on these lines that we must look in large measure for extension of our knowledge. A full discussion of what has been done already must, therefore, form an important part of this report.

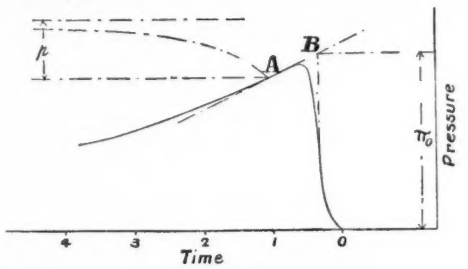


Fig. 3.

Let H be the calorific value of the mixture before combustion, let h be the heat lost at some point A on the record (taken on a revolving drum) connecting the pressure and the time—see fig. 3. The energy in the gas is then H − h. The gas at this point is, however, certainly not in thermal equilibrium; and is probably neither in chemical equilibrium nor at rest. If therefore the loss of heat was suddenly arrested at A, the pressure would change owing to the more or less gradual attainment of equilibrium in all three respects. The equilibrium value of the pressure would be reached asymptotically, as shown by the dotted line. When equilibrium has been attained, the energy of the gas is all thermal and equal to H − h; and the temperature can be calculated in the ordinary way from the pressure. The problem therefore is first to find or estimate the heat-loss h which has occurred at some point on the explosion record, and then to find or estimate by how much the equilibrium value of the pressure, if there were no further heat-loss, would differ from that shown on the record.

This change of pressure (marked p on the diagram) is due partly to the combustion of the gas remaining unburnt at A and partly to the equalization of temperature by convection. It may also be due to some extent to the damping-down of the motion of the gas set up by the explosion.

The sooner the point A is taken, the less will be the loss of heat; but the greater, on the other hand, will be the departure from equilibrium conditions. The principal workers in this field, Mallard and Le Chatelier and Langen, assumed that the latter might be neglected if the point A were taken at the point of inflexion on the falling curve; and they estimated the loss of heat by prolonging this curve backwards, as shown. They assumed, in fact, that the pressure given by the point B was that which would ultimately have been reached had the explosion taken place in a vessel with walls impervious to heat.

It is difficult to justify this procedure on *à priori* grounds; the only satisfactory justification is to show, by independent evidence, that it leads to correct results. The main object of this section of the report is to examine such evidence as there is of this kind, to point out the defects in it, and to suggest experimental methods by which they could perhaps be remedied.

In so far as the heat-loss and the departure from equilibrium are dependent on surface phenomena, a definite estimate of their amount can be obtained by a comparison of explosions of the same mixture in vessels of different sizes.

Many years ago Berthelot tried this experiment—firing hydrogen and oxygen, in explosive proportions, in vessels of 300 c.c. and 4000 c.c. respectively. It is stated that the pressure reached was very nearly the same, which would show that such part of the cooling and other corrections as depends on the surface of the vessel is small in the case of this mixture.

Materials for a more accurate comparison are to be found in the extensive researches of Mallard and Le Chatelier, and of Langen. The French experimenters worked with a cylindrical vessel 17 cm. × 17 cm.; whereas Langen used a sphere 40 cm. in diameter. The ratio $\frac{\text{surface}}{\text{volume}}$ was 2·3 times as great in the first as in the second case.

The following table shows the results obtained in two instances, in each of which the composition of the mixture was practically identical in the two sets of experiments:—

Mixture.	Observer.	Π_0.	Cooling Correction.
2 vols. air . .) 1 vol. (H_2 + O))	Mallard and Le Chatelier, Langen	7·40 7·50	14 per cent. 8 ,,
2 vols. air . .) 1 vol. (CO + O))	Mallard and Le Chatelier, Langen	7·50 7·50	7½ ,, 8 ,,

Π_0 is the pressure reached in the explosion in atmospheres after correcting for cooling in the manner described above, when the initial temperature is 0° C. The cooling correction, or excess of the pressure at B (fig. 3) over that at A, is shown in the last column. Figs. 4 and 5 (which are taken from Langen's paper) show a comparison between the curve adopted by Langen, as representing the results of his experiments, and Mallard and Le Chatelier's observations.

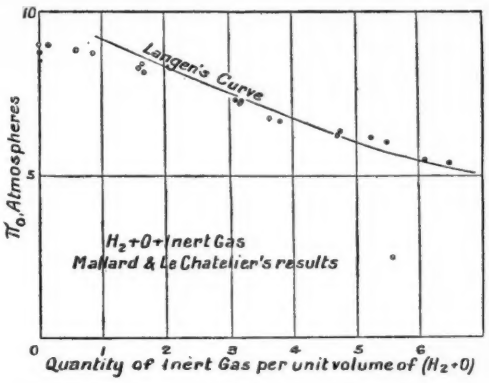


Fig. 4.

On the whole, the agreement between the two sets of experiments is very fair, and the deviations are not such as to suggest that any very great error has been made in estimating such part of the corrections for heat-loss or for unburnt gas as depend on the surface of the vessel. If, for example, Langen were, on the average, 4 per cent. out from this cause, Mallard and Le Chatelier would be 9 per cent. out, and would differ by 5 per cent. from

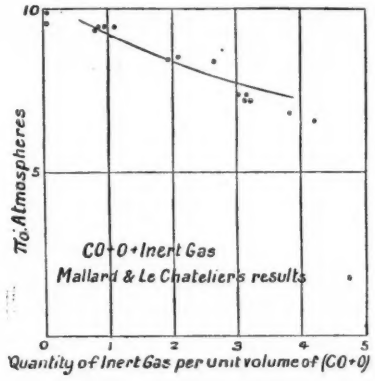


Fig. 5.

Langen. Differences of this amount do occur, but they do not seem to be systematic. Further experiment of the same kind on vessels with a greater difference of size but of similar geometrical form is, however, desirable.

The question remains, how far the corrections really are surface corrections. This appears to the Committee to be the most important question of a general character awaiting solution in connection with gaseous explosions when regarded as a means of

investigating the properties of gases at higher temperatures. It will be convenient to discuss each of the corrections enumerated above with special regard to this question.

Loss of Heat.—That much of the heat-loss goes on by direct conduction to the walls, and is, therefore, a surface phenomenon, is obvious. But there is reason to believe that the loss by radiation, which certainly exists in any flame, is practically important.

(*a*) Measurements of the temperature reached in an explosion by means of a platinum thermometer, under circumstances which render very improbable any loss of heat by conduction from the gas whose temperature is measured, show that this temperature is considerably lower than is to be expected from the heat of combustion of the gases and the specific heat of the products. Professor Callendar pointed out, in the discussion of these experiments, that there was probably a good deal of radiation, and stated that he had found that an ordinary bunsen flame might radiate up to 15 per cent. of its heat.

(*b*) Recent experiments, in which the loss of heat during an explosion was directly measured by finding the rise of temperature of the walls, showed that in a certain coal-gas explosion it amounted to about 12 per cent. of the whole heat at the moment of maximum pressure. Estimated by Mallard and Le Chatelier's extrapolation method, the loss was at most 5 per cent.

The prevailing opinion seems to be that most simple gases cannot be made to radiate by direct heating. If this be so, the radiation must take place in the act of combustion. It seems very probable that when (say) hydrogen and oxygen combine, a certain part of the energy of combination passes into the form of internal vibrations of the steam molecule, and that a large proportion, if not all, of this part is ultimately radiated away. If this be the case, a definite proportion of the heat produced in combustion is always lost; and a comparison of explosions in vessels of different sizes would not reveal this loss.

Thermal Equilibrium.—When an explosive mixture of gases is ignited in a closed vessel, the effect of the change of pressure during the progress of the flame from the point or points of ignition is to raise the temperature round about these points much above the mean temperature; and, on the other hand, the temperature attained at the places which are last reached by the flame, and where the gas is compressed before instead of after ignition, is much below the mean. Even in a vessel whose walls are impervious to heat, the difference of temperature between the points first and last inflamed might amount to 700° C. at the moment of maximum pressure. In a real explosion, the cooling effect of the walls causes the temperature to range from perhaps 300° or more above the mean (as shown by the pressure) right down to the wall-temperature at points close to the metal. The existence of large temperature differences in the gas close to the walls of an engine cylinder was first experimentally demonstrated by Professor Burstall with the aid of platinum thermometers.

If the volumetric heat of the gas were constant, the equalization of these temperature differences by convection and conduction, could it take place without loss of heat, would cause no change of pressure. The volumetric heat is, however, not constant, but may quite possibly be 50 per cent. greater in the hottest than in the coldest part of the mass. The attainment of thermal equilibrium must, in fact, cause a change of pressure, and would contribute to the correction which has been designated p (see fig. 3). The amount of the change might be the subject of rough calculation, taking an assumed distribution of temperature and assuming values for the volumetric heat. Such a calculation in the present state of knowledge would only be of value as showing the possible order of magnitude of the quantity sought; and the assumptions made could, therefore, be of a character to make the calculation fairly simple. More accurate knowledge both of temperature distribution and of thermal capacity will enable greater accuracy to be attained in the estimation of this correction, which will be of such a kind that a method of successive approximation can be pursued—the revised values of thermal capacity resulting from its application being applied to a more accurate calculation of the correction if necessary.

The temperature variation set up by the cooling action of the walls is a surface phenomenon, and as such the correction which it necessitates can probably be determined and eliminated by experiments with vessels of different sizes. The variation caused by the change of pressure during the period of inflammation is not of this character; and the necessity for a large correction on this account is quite consistent with the observations of Berthelot, or of Mallard and Le Chatelier, and of Langen. In these experiments the maximum pressure reached in the explosion was measured; and at the time of maximum pressure very large differences of temperature are known to exist at a distance from, and quite independent of, the walls.

Soon after maximum pressure, however, the temperatures at points remote from the walls are equalized to a large extent by convection currents. There then remains only the layer of gas near the walls to be considered in this connection. If, therefore, the measurements be postponed until a long enough time has elapsed to admit of this internal equalization, the correction becomes of the surface kind, and can be dealt with by the method appropriate to corrections of that type. But in that case the heat lost will be too large a quantity to admit of rough estimation. It must be directly measured.

Chemical Equilibrium.—The view that chemical equilibrium is not attained until some time after the moment of maximum pressure was first put forward by Clerk in 1885, who then expressed the opinion that the greater part of the so-called "suppression of heat" in explosions was to be ascribed to this cause. On the the other hand, Continental writers have almost completely ignored it. For example, Langen makes practically no reference to it in his paper. It can hardly be doubted, however, that in many explosions, especially of weak mixtures, a considerable amount of the energy is in the chemical form at the moment of maximum pressure. On the other hand, it seems probable to the Committee that the amount of unburnt gas at this moment in such experiments as those of Langen was not such as to very greatly affect the results. This belief is based on the supposition that the incomplete combustion is due to the cooling action of the walls. It seems probable that very shortly after the attainment of maximum pressure—that is, within a time small compared with that required to reach maximum pressure—the transformation of the chemical energy into thermal form is everywhere complete except in a thin surface layer where this transformation is retarded by the cooling action of the walls.

If this view be accepted, the correction of the results for incomplete combustion is of the nature of a surface correction, and can be determined by comparing the pressures reached by the same mixture when exploded in vessels of different sizes.

In the discussion of this important matter, the Committee have derived great assistance from the experience of Professors Dixon and Bone, who have made a special study of the velocity of chemical action in gases. These gentlemen are of opinion that though such action may be of great complexity—involving in many cases several successive molecular operations, yet, if it is not retarded by the presence of cold foreign bodies, it will generally be completed within a period which, for the purposes of gas-engine theory, may be regarded as negligibly small. In the simple case of the explosion of hydrogen and oxygen, they consider that the complete transformation of the mixed gases into steam at any given point is complete within a time measured by the interval between molecular collisions. When the action is more complicated, as in the explosion of carbon monoxide and oxygen in the presence of water, or in the combustion of hydrocarbons, the period will be larger, but will still be measured by thousandths of a second.

Some direct evidence that incomplete combustion in an explosion is mainly, if not entirely, a surface phenomenon is to be found in Hopkinson's measurements of the temperature at points within a large explosion vessel by means of a platinum thermometer. A photographic record of the resistance of a fine platinum wire immersed in the gas showed that when the flame reached it the temperature rose in less than $\frac{1}{40}$th of a second from 20° C., which was the temperature of the unburnt gas, to about 1250° C., which was that of the burnt gas, and that it remained at the latter figure quite steadily except in so far as the increase of pressure in the vessel caused it to rise. In other words, there was no increase of thermal energy except that due to work done upon the gas from outside. The mixture was one part of coal gas to nine parts of air—a slow burning mixture; and the time taken to reach maximum pressure was about a quarter-of-a-second, or at least ten times that required for combination of the gases at any one point. It is true that the vessel was of rather large size—about 6 cubic feet capacity; but, on the other hand, owing to the fact that the platinum wire extended over about 1 cm., so that the flame took an appreciable time to completely envelop it, it is probable that the period of $\frac{1}{40}$th of a second, given above, is a superior limit which greatly exceeds the actual time taken to effect the combination at any one point.

On the other hand, it cannot be doubted that combustion must be greatly retarded in the neighbourhood of the cold metal walls; and there is nothing to show that this surface retardation is not sufficient to account for all the phenomena of delayed combustion. A simple calculation based upon the rate of flow of heat per square foot into the metal of a gas-engine cylinder (which is roughly known from measurements of the heat carried away by the jacket water) shows that the mean temperature of the exposed surface at points separated by an inch from the cooling water cannot exceed quite a moderate value. Probably about 200° C. is a superior limit for the cylinder liner. Similar calculation of a still rougher kind, but sufficiently accurate to give the order of magnitude of the quantity sought, shows that the fluctuation above and below the mean in the course of a cycle is very unlikely to exceed 20° C. The latter conclusion has been confirmed by some experiments made by Professor Coker. Measuring the cyclical variation of temperature of the inner surface of a 12-H.P. gas-engine cylinder by methods similar to those adopted by Professors Callendar and Nicholson in their well-known work on the steam-engine, he found that the maximum was only 7° Fahr. in excess of the mean. The direct measurements by Professor Hopkinson of the temperature of the walls of an explosion vessel lined with copper strip also lead to the conclusion that it is quite moderate. This cold metal must obviously profoundly affect the combustion in its neighbourhood. In a layer of gas of appreciable thickness, the combustion will be of a smouldering character—depending upon the velocity with which the unburnt gas in contact with the walls can diffuse into the hotter regions at a distance from them, and so be brought to the ignition temperature. This layer being cold and highly compressed might account for a considerable fraction of the heat, though its actual thickness may be only a few tenths of a millimetre. It would appear probable that the continued burning which undoubtedly goes on after the time of maximum pressure in many explosions, and probably

also occurs during the first portion at least of the expansion stroke of a gas-engine, is mainly of this character.*

Motion of the Gas.—In many explosions intense vibratory motions of the gas are set up. The effect of these sometimes appears with a quick-period indicator as a rapid variation of pressure. It is a question of some importance how these motions affect the mean pressure shown by a gauge. The damping-down of the motion which occurs in consequence of viscosity, of course, only means that the motion becomes distributed among the molecules in a random way, instead of following a definite arrangement. The total kinetic energy remains the same. But it is not certain that the mean effect on a pressure-gauge of the molecular impacts will be the same. This is a question which might well be considered by someone to whom the methods of the kinetic theory of gases are familiar. It is, of course, not a surface phenomenon.

Results of Observations.—The temperatures reached in these explosion experiments range from about 1300° up to 3000° C. Temperatures of below 1500° are, however, obtained by the use of weak mixtures, involving slow burning and large cooling corrections, and but little reliance can be placed on the results. Langen made very few observations on mixtures giving a lower temperature than 1500°, and takes that as the lower limit of the range of temperature to which his observations apply. The extreme upper limit of the constant pressure experiments is 1400°. The temperature of 3000° C. is about that reached in the explosion of hydrogen and oxygen in their combining proportions. This is much above the mean temperature ordinarily reached in the gas-engine, the upper limit of which may be put at about 2000° C., though it is probable that 2500° or more is occasionally reached locally. Langen, however, places the upper limit of the application of his formulæ at 1700° C., on the ground that there is dissociation of the carbon dioxide at higher temperatures than that. There does not seem to be much reason for this limitation; for the effects of dissociation (provided that equilibrium is attained) are indistinguishable from those of increasing specific heat, and should be included in the change of energy. Dissociation may give rise to errors in the temperature measurement; but there is reason to suppose that the dissociation which occurs in the carbon dioxide in steam at a temperature of 2000° C. is too small to cause any material change of volume, though it may mean considerable absorption of heat.

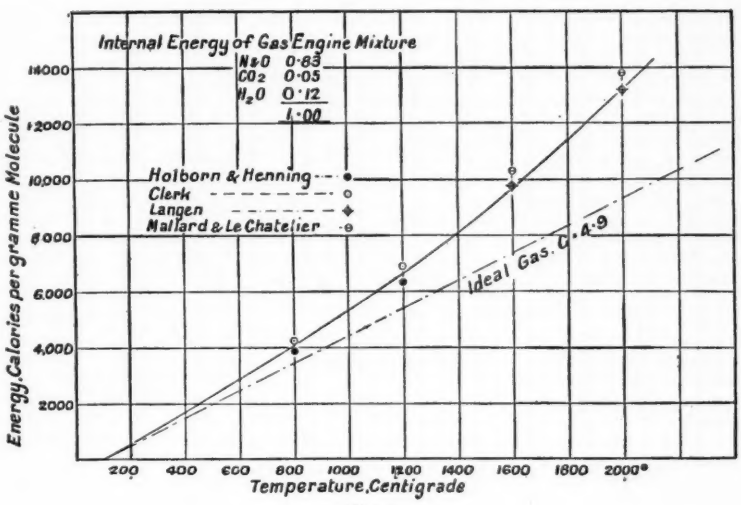


Fig. 6.

The formulæ given by Langen as representing the results of his observations are as follows:—

$$\text{Air } \bar{C} = 4{\cdot}8 + 0{\cdot}0006\,t$$
$$CO_2\ \bar{C} = 6{\cdot}7 + 0{\cdot}00260\,t$$
$$H_2O\ \bar{C} = 5{\cdot}9 + 0{\cdot}00215\,t$$

where $\bar{C}$ is the mean thermal capacity over the range 0° to t° C. The explosion pressures predicted by the use of these formulæ agree well with the observed pressures except in the case of mixtures of carbon monoxide and air, where they are a good deal too high. In the other cases, the maximum deviation is about 4 per cent.

Mallard and Le Chatelier represent their results by formulæ which differ greatly from the above in the case of carbon dioxide and steam, though the formula for air is the same. This discrepancy must be due in some way to the method of reduction adopted; for, as already pointed out, the explosion pressures reached with mixtures of the same composition are very nearly the same.

Taking Langen's values, the following table exhibits the energy of the various simple gases, and of the mixture on which Clerk experimented, at 1600° and 2000° respectively. The energy of the same gases at 800° and at 1200°, based on Holborn and Henning's and on Clerk's results, is also given for comparison. The results are given in calories per gramme molecule. To reduce to foot-pounds per cubic foot, multiply by the factor 3·96.

—	800°.		1200°.		1600°.	2000°.
—	Clerk.	Holborn and Henning.	Clerk.	Holborn and Henning.	Langen.	Langen.
Air	—	3570	—	5840	8700	11500
Carbon dioxide . .	—	6460	—	10880	17000	23300
Steam	—	4670	—	7930	14400	19900
Gas-engine mixture .	4250	3840	6900	6340	9800	13200
Ideal gas*	3430		5400		7350	9300

* C = 4·9.

The results for the gas-engine mixture are plotted on fig. 6, on which points obtained by Mallard and Le Chatelier's formulæ are also shown.

The energy of gas-engine mixture at 1400° according to Clerk, Holborn and Henning, and Langen respectively would be as follows:—

Clerk	8300
Holborn and Henning	7700
Langen	8300

It will be seen that the agreement between Clerk and Langen is close—both being about 8 per cent. higher than Holborn and Henning. But it is to be observed that this temperature is just outside the range of all three sets of experiments.

The Committee are of opinion that values of the energy obtained from explosion records are not subject to any very great errors on account of heat-loss by conduction to the walls of the vessel, nor on account of incomplete combustion; but that they are affected by errors of quite unknown amount—due, first, to heat radiated, and, secondly, to the want of thermal equilibrium at the time when the pressure is measured. For the purpose of testing the first of these conclusions, it is very desirable that further experiments should be made on explosions in vessels of greatly different size but of similar form. The opinion entertained by the Committee that incomplete combustion is a surface phenomenon, on which this conclusion as to the validity of the method is based, also requires further confirmation. As regards the second conclusion, further experiment on the actual amount of heat radiated by burning gas is urgently required, and also experiments to confirm or negative the effect of the nature of the wall-surface upon the pressure reached in an explosion. The effect of want of thermal equilibrium can be determined up to a point by calculation. But before such calculation can be usefully made, it is desirable that further information should be obtained as to the temperature distribution after an explosion, especially in the neighbourhood of the walls. It should not be difficult to get an idea of this, sufficiently accurate for the purpose, by means of platinum thermometers.

The most hopeful way, however, of making use of explosions to give definite information as to the properties of gases would appear to be to directly measure the heat lost in the explosion. If this be done, it is possible to defer the pressure measurement until such time as equilibrium conditions (except those that depend on the surface of the vessel) have been attained.

Measurement of Temperature.

In all the experiments for the determination of the energy function which have been described above, the measurement of the temperature is ultimately based upon the pressure or volume changes of the gas. In the constant-pressure experiments of Holborn and Henning, the temperature of the gas before entering the calorimeter was measured by means of a thermocouple which had been compared with a constant volume nitrogen thermometer up to 1600° C. In the explosion experiments, the mean temperature of a gas is inferred from its pressure. Similarly, in the analysis of the gas-engine diagrams, the gas is itself the thermometer. The mean temperature at any point is taken as proportional to the product pv, and the actual temperature at one point in the cycle (a knowledge of which is necessary for getting absolute values) is obtained either by estimating the quantity of gas present in the cylinder or by direct measurement with the platinum thermometer, as was recently done by Callendar and Dalby.

The temperature scale so obtained is probably sufficiently definite, at any rate for the purpose of gas-engine theory, since the mixture to which it is applied does not vary very greatly in composition, and always consists mainly of nitrogen. It is not so certain, however, that this scale agrees with the absolute thermodynamic scale; and the question of the possible amount of the

* Professor Bone is doubtful whether "smouldering combustion" plays so considerable a part in gaseous explosions as is here suggested.

deviations at temperatures of 1500° and over is of great importance in connection with the present inquiry.

So far as the Committee are aware, the experiments of Joule and Thomson still remain the only comparison between the various gas-scales and the thermodynamic scale. This comparison only extended to about 200° C., and is, of course, of no application to the problem now under discussion, except in so far as it gives an idea of the differences to be expected at higher temperatures. What it really shows is that thermometers constructed of the more permanent gases are all so closely accordant with the thermodynamic thermometer as to lead to the belief (as a matter of induction, and quite independently of the kinetic or any other theory) that there is really some definite cause tending to make a gas—as such and apart from its composition—obey the law $\frac{pv}{\theta}$ = constant. It would appear that the small deviations from this law (sometimes one way and sometimes the other) which are observed must be due to disturbing causes depending on the nature of the gas, whose influence may be in either direction and is of very various amount, but is at low temperatures small compared with the tendency to obey the perfect gas law. This view being accepted, there is a strong presumption that, if a number of thermometers constructed of different gases be compared at high temperatures and be found to agree fairly well, then they all agree with the thermodynamic scale at least as well as they agree with one another. It is upon the agreement between different gas-thermometers that our belief in the measurement of temperature is really founded; and, so far as it goes, the foundation seems to be sound.

The nitrogen thermometer has been used with an iridium bulb up to 1600° C., but no other gas has been taken above 1100° C. At the latter temperature the differences between thermometers constructed of hydrogen, nitrogen, and air are quite negligible for the present purpose. Rather more deviation has been observed in carbon dioxide; but having regard to the small percentage of this gas which is ordinarily present in the gas-engine mixture, it is not likely that temperatures up to 1100° C., calculated in the usual way from the indicator diagram, will differ much from the true temperatures on the thermodynamic scale. This 1100° C. is, however, not much above the lower limit of the gas-engine range; and as to what goes on in the upper part of that range we have little or no evidence.

When considerable deviation from the gas-laws at high temperatures is observed in the case of any gas, it is usually ascribed to dissociation. For example, if comparison be made of two constant-pressure thermometers filled respectively with hydrogen and with iodine vapour, they will be found to agree up to about 1000° Abs. The iodine thermometer will then begin to read higher than the hydrogen thermometer until, when the latter reads about 1800° Abs., the former will read about double that amount. When the gases are hotter still, the temperature shown on the iodine thermometer will continue to be double that shown on the other. In this case the departure between the two thermometers is accompanied by a change in the absorption spectrum of the iodine vapour; and the whole phenomenon is expressed by saying that the iodine molecule has been split up or dissociated. In the case of a compound gas, this dissociation sometimes takes the form of an actual separation of the constituents, which can be detected by diffusion. A great deal of experimental work has been done with the object of ascertaining to what extent the gases carbon dioxide and steam split up at high temperatures. These gases are constituents in most gas-engine mixtures; and if they dissociate to any considerable extent, there will be a corresponding effect upon the $pv\theta$ relations of the mixture of which they form a part. So far, however, there is, in the opinion of the Committee, no conclusive evidence that either steam or carbon dioxide is dissociated to an extent which is material for the present purpose. Slight traces of dissociation have undoubtedly been found in both cases; but the method of experiment is such as to leave it doubtful how far these have been conditioned by the nature of the walls through which the dissociated gas is diffused. It must be observed, moreover, that carbon dioxide and steam usually form only a small part of the mixture in the gas-engine; and that a considerable amount of dissociation of these gases would therefore be necessary to produce much effect upon the pressure of the whole. Again, such dissociation, if it occurs, must have an effect upon the energy of the gas out of all proportion to the effect which it has upon its temperature. Take, for example, the case of a mixture formed by the explosion of carbon monoxide and air and containing 10 per cent. of carbon dioxide, the remainder being nitrogen. If, by heating, one-tenth part of the carbon dioxide be split up into carbon monoxide and oxygen, the resulting change of pressure of the whole mixture will be only one two-hundredth part. But this amount of dissociation could only be effected by the absorption of an amount of heat of the order of 10 per cent. of the total heat of combustion of the gas. In other words, the mean specific heat of the mixture, as determined by the explosion, would be, roughly, 10 per cent. lower than if there had been no dissociation. Any considerable departure from the gas-laws in such a mixture, if it be ascribed to dissociation at all, must, therefore, be put down to dissociation of the nitrogen, which might conceivably occur at 2000° C.—just as iodine vapour is dissociated at a much lower temperature. It does not seem likely, however, that if nitrogen dissociates, its splitting-up would be accompanied by any visible change in its physical properties, such as is observed in the case of iodine. The phenomenon in this case would be rendered evident only by the departure from the gas-law, and possibly by absorption of heat.

It would appear, therefore, that our knowledge of thermometry at these temperatures is more likely to be advanced by direct experiments on the relation between the pressure or volume and the temperature, than by looking for other evidences of dissociation. The difficulty in carrying the comparison of different gas-thermometers to very high temperatures has hitherto lain in the absence of any material sufficiently refractory to withstand such temperatures, and at the same time sufficiently impervious to the gas. Dr. Harker (to whom the Committee are greatly indebted for much information upon this subject) believes, however, that he is now in possession of a material which will satisfy both of these conditions up to a temperature of 1800° C.; and he has suggested that an attempt should be made to compare thermometers constructed with nitrogen, with carbon dioxide, and with argon up to that temperature. If the nitrogen and argon thermometers are found to agree, then, by reason of the great difference in the constitution of these gases, it is almost certain, as explained above, that each agrees with the thermodynamic scale. If, on the other hand, they do not agree, then the presumption is in favour of the argon thermometer, because this gas is supposed to be monatomic and to be incapable of dissociation. The Committee venture to express a hope that research on these lines will be commenced and carried to a conclusion. They believe that the results obtained will be of very great importance in the investigation of explosions and in the theory of the gas-engine, and it seems to them an inquiry eminently fitted for the National Physical Laboratory.

The comparison of gas-thermometers is, however, not the only way in which the problem of thermometry at high temperatures may be attacked. Another method, and one that is more satisfactory in some ways because it is more fundamental, is to investigate the dependence of the energy upon the density of the gas. As pointed out at the commencement of this report, any interdependence between energy and density at a given temperature must be accompanied by a corresponding deviation from the perfect gas-law, and investigation of change of energy with density must be the ultimate basis of gas thermometry. The Joule-Thomson experiment was, of course, of this character. Since then Joly has determined the change of specific heat of carbon dioxide at pressures ranging up to the critical pressure. But these determinations refer only to temperatures of the order of 100° C.

As was pointed out at the commencement of the section of this report dealing with explosions, the corresponding measurement at very high temperatures can be very easily made when once the various corrections necessary to determine internal energy by explosion experiments have been satisfactorily performed. It is only necessary to compare the pressures reached in explosions of mixtures identical in composition but of different density. Should the pressures after explosion, when corrected, be proportional to the pressures before explosion, then the energy is independent of the density; and we have proof that the gas-law holds up to the temperature reached by the combustion. On the other hand, a departure from the proportionality would imply a corresponding departure from the gas-laws, the amount of which could be calculated. Mallard, Le Chatelier, and Langen have made very careful comparisons of this kind; and they have found that the actual maximum pressures reached in the explosions are in many cases very approximately proportional to the pressures before explosion. Petavel has found that this proportionality is not much altered even when the density of the gas is increased seventy times. This may be regarded to some extent as evidence that there is no very great difference between the gas scale and the thermodynamic scale at the temperatures of 1700°, or more, which were reached in these experiments. But it must be observed that this inference is subject to the same limitations as the determinations of internal energy based upon these experiments. It cannot be regarded as having a secure foundation until the various doubtful questions in regard to heat loss and delayed combustion, which have been raised above in this connection, have been satisfactorily determined.

The Committee think that they can usefully continue their work in the direction of suggesting, and to some extent organizing, research on the lines which have been foreshadowed in this report. Research of this kind is expensive; and the Committee are of opinion that their work would be greatly facilitated if they had some funds at their command. They therefore recommend that they be reappointed, and ask for a grant of £100. [The grant given was, however, only £75.]

The North of England Gas Managers' Association.—The sixty-third half-yearly general meeting of this Association will be held at the Masonic Hall, Wellington Street, Stockton-on-Tees, on Saturday, the 3rd prox., under the presidency of Mr. William Ford, who will deliver his Inaugural Address. A suggestion will be considered for altering the dates of the meetings to the first Saturday in May and the last Saturday in September. In the morning, there will be an inspection of the gas-works; and at the opening of the business meeting, the Mayor of Stockton-on-Tees and the Chairman of the Gas Committee will welcome the Association. Subsequently there will be a dinner at the Queen's Hotel.

REGISTER OF PATENTS.

Rotary Gas-Engine.

FRIEND, J. E., of Wellington, New Zealand.

No. 18,476; Aug. 15, 1907.

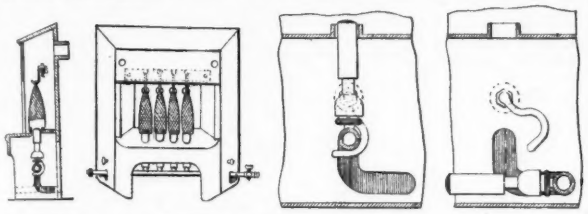
This invention relates to reversible rotary gas-engines of the type wherein the mixture explodes between a movable abutment and a piston rotated in an annular chamber and operated in synchronism with the abutment. It more particularly relates to that class of the above type wherein the air and gas are admitted to a single or multiple cylinder engine through compressors operated from the main shaft, and through mixture-chambers or valve-chests provided with non-return or positively actuated valves, and wherein the ignition is controlled from the main shaft of the engine. It has also been proposed to reverse rotary gas-engines of this type (and to which the air is supplied through a compressor operated by the main shaft) by means of two-way cocks permitting the passage of the gaseous mixture to and from the inlet and outlet valves respectively, which valves change their function when the engine is reversed. In its general details of construction the engine is similar to the rotary steam-engine described in the same inventor's patent No. 886 of 1907.

Incandescent Gas-Fires.

DELAGE, M., of Paris.

No. 28,217; Dec. 21, 1907.

This invention relates to incandescent gas-fires of the type in which refractory bodies for heating by radiant heat are employed. It consists in part of improvements in arrangements for rendering the gas supply system easily removable for cleaning purposes without removing the heating mantles. It further consists in a specially-arranged gas supply pipe divided longitudinally by a partition and provided with a two-way cock for feeding gas to either side of the partitions or to both sides.



Delage's Incandescent Gas-Fire.

The accompanying illustration shows: A cross-section of a fire and radio-incandescent bodies; the fire in front view in perspective; one of the side walls of the fire on a larger scale, this wall being viewed from the inside, and the burners being in the working position; the same wall, the burners being brought into the cleaning position.

In the working position, the upper ends of the burners are within the burner rings, which are of slightly larger diameter than the heads of the burners, and are set in corresponding holes in the plate which forms the lower part of the fire. The heating mantles are suspended by hooks of refractory material from a cross-bar held in place by the sides and provided with notches. The mantles embrace by their lower parts the outer circumferences of the burner rings, and are thus kept in an invariable position by their mode of suspension, and by the rings when the supply main with the burners is shifted. The front plate of the fire may be fixed to the body itself by screw buttons, and be thus rendered movable for the purpose of facilitating access to the cross beam supporting the mantles, and, consequently, the putting in place of the latter.

In order to permit of the shifting of the supply pipe and the burners for cleaning purposes, the supply pipe is engaged by its ends in openings in the form of right-angled slots made in the sides of the fire. In the working position the supply pipe is maintained at the upper part of the opening by a hook placed inside on either side of the fire and worked from the outside by a button. When the hooks are raised, the pipe is free to descend in the openings, carrying with it the burners, which are withdrawn from the rings. It can then be pushed up to the end of the horizontal parts of the openings; and in this position the burners can be turned down horizontally—presenting their grids at the front opening of the floor of the fire, where the grids may be cleansed from any dust which obstructs them.

Retort-Furnaces.

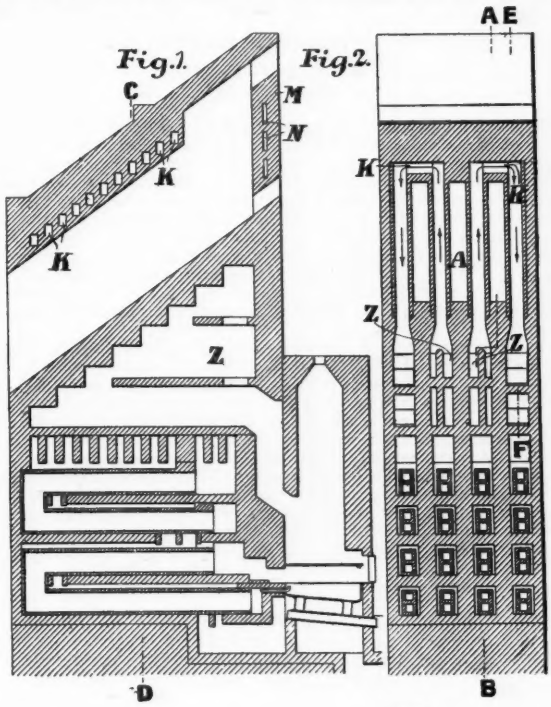
RIES, HANS, of Munich, Germany.

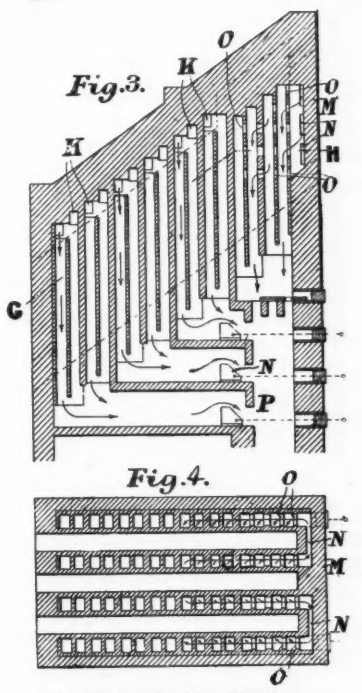
No. 8370; April 15, 1908.

This invention has for its object to improve the arrangement of the heating channels, more particularly in furnaces having inclined retorts. To secure the best results and a uniform evolution of gas from the coal contained in the several parts of the inclined retort, the patentee considers it is necessary to provide for a regulation of the distilling process—an object accomplished to some extent by controlling the course of the heating gases by dampers in the heating channels. The present invention relates to an improved arrangement of the channels and their control by dampers, "so as to get full and definite regulation of the heating gases." The heating conduits, formed in the roof and walls of the retort-chamber (and through which the products of combustion pass) are arranged in groups separated from each other and communicating through damper-controlled openings with a discharge shaft or flue—the arrangement being such that the flow of the products of combustion can be regulated and caused to pass to any desired portion of the retort-chamber.

The invention is described by the patentee and shown as applied to a furnace of the type referred to in patent No. 14,341 of 1907, though applicable to any furnaces of a similar nature. Fig. 1 is a longitudinal vertical section on the line A B of fig. 2. Fig. 2 is a vertical section on the line C D of fig. 1. Fig. 3 is a vertical longitudinal section through the upper part of the furnace on the line E F of fig. 2. Fig. 4 is a horizontal cross-section on the line G H of fig. 3.

The retort-chambers have roofs formed higher at the upper ends of the chambers, so that an additional space is formed above the line followed by the greater part of the roof. Into this widened portion open the charging shafts through which the coal to be distilled is fed. The gas collects in the space, to which an ascension pipe (not shown) for discharging the gas is connected. The chambers are arranged side





The Ries Carbonizing Chambers.

by side (three are shown), and are separated from each other by vertical flues or conduits, and from the lateral walls of the furnace by vertical flues. These several flues are connected together at the top by transverse roof conduits K, which, however, are arranged only in the lower and central portion of the roofs. The lateral conduits adjoining the upper portion of the roof are connected to conduits N provided in the back wall M of the furnace—perforations O connecting these flues to the conduits N in the rear wall.

In order that the amount of gas discharged from the heating conduits may be regulated, the conduits are provided with dampers controlling the flow of the products of combustion from one or more heating conduits to the discharge shaft. In the construction shown, the channels are arranged in groups—four being shown. Each group

is connected with the main discharge shaft or flue P, which leads to the regenerator, by separate channels R, S, T, U, one for each group; and each channel may be closed relatively to the main discharge shaft P by sliding dampers or other suitable devices. "In this way, more rapid circulation of the heating gases at the lower part of the retorts than at the upper part, or at any other portion thereof, may be obtained." In the construction shown, the channels for supplying heating gas and those for supplying air to support combustion terminate adjacent to each other immediately below the outwardly-inclined surfaces of the seating on which the retort-chambers are carried. The hot gases from the discharge shaft or flue P pass to the regenerator in the lower part of the furnace, as shown in figs. 1 and 2, where they give up part of their heat to the air, which then passes to the channels. The regenerator is of the usual construction.

Manufacturing Water Gas and Producer Gas.

PETTIBONE, H., of New Rochelle, N.Y., U.S.A.

No. 8715; April 21, 1908.

This invention relates to improvements on patents Nos. 5912 and 6302 of 1904—"to provide for economically and effectively heating air and vaporizing water to produce a hot air and steam supply to a generator by means of waste heat of outgoing hot gas from the generator, whereby a uniform supply of hot air and steam or water vapour may be fed by the generator at a minimum cost, and the gas may be incidentally cooled on its way to the scrubber." Another object of the invention is to provide improved means for admitting a compressed aeriform fluid in sudden short puffs, to clear the interstices of the fuel from ash and cinder—"thus leaving the fuel comparatively clean, loose, and open, so that the generation of gas may be resumed in a normal and satisfactory manner."

Fig. 1 represents a top plan view (partly in section) of the apparatus. Fig. 2 is a sectional front elevation, with part broken away. Fig. 3 is a side elevation, with parts in vertical section and parts omitted.

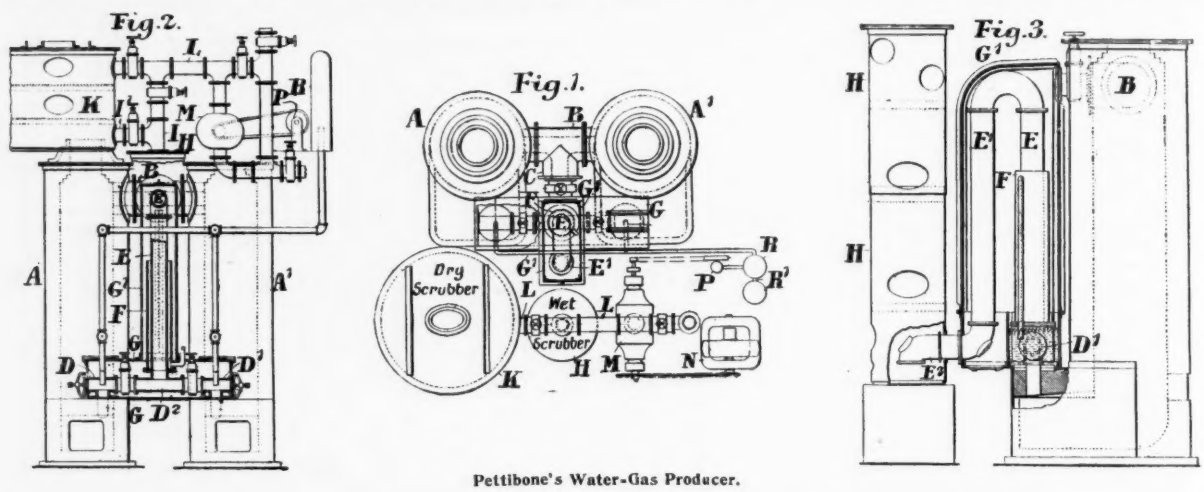
The generators are made in pairs, A A^1, connected at the top by a short cross pipe B, connected with an air-heating and water vaporizing chamber and apparatus. At the bottom the generators are provided with horizontal extensions, and at the rear with suitable openings and doors. At top the chambers have door frames and top lids or doors, where they are charged with coal and where bars may be inserted for regulating the beds of fuel. The generators are constructed with sheet iron or steel shells and fire-brick linings in the usual manner.

Upon the bottom extensions is a water-vaporizing box containing the gas outlet pipes and valves, composed of the connection D having a drop pipe extended connecting with the interior of the extensions and a similar pipe section D^1 and connection, and a central section D^2. With the central section D^2 is connected the stand-pipe E, rising nearly to the top of the generator, and there connecting by a return-bend with the second stand-pipe E^1, which is provided at the bottom with an elbow having a hand-hole and cover; also a curved discharge end E^2 extending downward in the bottom of the wet-scrubber H, as shown in fig. 3. This downwardly curved extension forms a dip-pipe, and is immersed in liquid, forming a seal.

There is also connected a water-jacket pipe F, which, preferably, extends up around the gas take-off pipe E a little more than one-half its height, as shown in figs. 2 and 3. With the lower end of this water-jacket pipe connects a water supply pipe, and near the upper end connects an overflow pipe which extends down into the water-box and vaporizer G, which is constructed to completely enclose the gas take-off stand-pipes E and E^1. The top is provided near each end with an air inlet opening to which are applied sliding covers or dampers, as shown in figs. 1 and 2. The bottom of the central extension of the chamber G is also provided with an air inlet opening controlled by a sliding damper. The central part of the box is provided with a partition plate for separating the water compartment from the hot-air compartment, as shown in fig. 3. With the upper part of the air-heating chamber G^1 is connected a short pipe C, having a valve and leading to the cross pipe B, which is preferably made as a T, so that the connection C forms a part of it. This pipe connection B C serves for admitting hot air and water vapour or steam into the upper parts of the generators.

The wet scrubber H has connecting with its upper end the gas-outlet pipe I, which connects with an upper pipe L and has a branch pipe I^1 connecting with the base of the dry scrubber K—of any well-known construction. At or near the top it is provided with an outlet pipe L, with which connects the pipe I, having a valve as shown in fig. 2. The outlet pipe L is extended so as to connect with a waste or blow-off pipe; and between the valves is a branch pipe to connect with the exhauster M. To one end of the shaft of the exhauster is applied a sprocket chain, which passes over a sprocket wheel on the shaft of an electric motor N and a second sprocket wheel, which serves for driving the exhauster.

In order to provide for loosening-up the beds of fuel when they become clogged with ash and cinder, there is compressed in suitable tanks or cylinders a gaseous or aeriform fluid—such as water gas, or a non-combustible gas, or air—which is admitted in sudden puffs or impulses into the base of one generator while the resulting products are



Pettibone's Water-Gas Producer.

passed off from the base of the other one. A gas or air compressor P is provided with a belt-wheel connected by a belt passing over the belt-wheel on the extended shaft of the exhauster; a pipe leading from the compressor to a compression tank R, or two tanks R R^1 may be provided, connected by a short pipe.

By vaporizing water and heating air by means of the outgoing hot gas passing through the stand-pipes as described, and feeding the moistened air to the generators, a mixed water gas and producer gas will be generated. The water-box G and the water-jacket F having been supplied with water, the sliding dampers are adjusted so as to admit air, and, supposing they are beds of fuel properly ignited in the generators, the exhauster M is put in operation, drawing gas off through the stand-pipes E E^1 and the scrubbers, and discharging it to a holder. During this operation, air will be drawn in through the openings into the water-box G and hot-air chamber G^1, where it will be heated and saturated with moisture or water vapour from the water which is heated in the box and jacket surrounding the gas take-off pipes. As the water vapour and air rise, they will be commingled and further heated by contact with the hot pipes in the top of chamber G^1 and then flow into the tops of the generators. The operation of the exhauster will draw the mixture of hot air and water vapour or steam down through the bodies of ignited fuel, where combustion and decomposition will be effected, mingled, and further heated by contact with the hot pipes in the top of the chamber G^1 and then flow into the tops of the generators. The operation of the exhauster will draw the mixture of hot air and water vapour or steam down through the bodies of ignited fuel, where combustion and decomposition will be effected, resulting in a mixture of water gas and producer gas.

When, in course of time (perhaps after several hours operation), the beds of fuel become clogged with ash and cinder, a blast of compressed gas in a sudden puff is admitted into the base of the generator A or A^1, where it loosens the body of impacted fuel and clean ash and cinder from the interstices of it. This operation may be repeated at short intervals until the body of fuel in the generator is well opened and cleaned. At this time the gaseous products arising from the fuel in one generator will be passed down through the body of fuel in the second generator, and thence off through the stand-pipes by the operation of the exhauster. At any desired time the second body of fuel in the generator may be cleaned in the same manner by a proper adjustment of the valves. When it is necessary to supply fresh fuel to the generating chambers, "the top doors may be opened and the fuel thrown in without interrupting the operation of the exhauster or generation of gas as the air and gas are drawn through the bodies of fuel by the exhauster."

Raising or Forcing Liquids.

HUMPHREY, H. A., of 38, Victoria Street, Westminster.

No. 19,341; Aug. 28, 1907.

In patent No. 20,736 of 1906 is described a method of raising or forcing water or other liquid by means of the energy developed by the explosion of a combustible mixture, wherein a fresh charge having been drawn into the combustion chamber the mass of liquid which returns under the pressure or head against which it is raised or forced is used for compressing this charge. In patents Nos. 18,594 and 18,595 of 1907, improvements in methods comprising this feature, and in apparatus for applying such methods, are described.

The present invention relates to further improvements, and consists in causing the returning mass of liquid to expel the products of combustion and also to compress a fresh charge. For this purpose, it is preferable to provide more than one combustion chamber, so arranged that, during the return of the liquid, the products are expelled from one chamber and a fresh charge is compressed in another.

Assuming that there are two combustion chambers each having free communication with the delivery pipe, and that in one of these there is a fresh charge under compression while from the other the products of combustion have been wholly or in greater part expelled, ignition occurs in the first cylinder, and the liquid is forced from the chamber along the delivery pipe. When the pressure of the expanding products of combustion has fallen below a certain value, the liquid in the second chamber begins to leave the chamber and to move into the delivery pipe. In so moving it draws a fresh combustible charge into the chamber. When, therefore, the liquid in the delivery pipe ceases its outward movement and begins to return, the first chamber contains products of combustion and the second chamber contains a fresh charge. The liquid now comes back into both chambers—expelling the products from the one and compressing the charge in the other. Ignition next occurs in the second chamber; and the cycle is repeated—the functions of the chambers being reversed.

The liquid moving outwards in the delivery pipe may take in more liquid through a suction pipe having a non-return valve, and which pipe may be so connected with the delivery pipe that there is an injector action aiding the suction. Preferably two or more suction pipes are provided opening into the delivery pipe at different points.

Admission and exhaust valves are provided for the operation of the chambers; and these may be controlled in any suitable manner. For instance, there may be plates in the pipes or chambers (so as to be deflected by the moving liquid) which may be connected with the valves in such a manner that the admission valve in the chamber in which expansion is occurring may be prevented from being opened by any lowering of pressure, and that the exhaust valve of the other chamber is prevented from being opened or remaining open while the charge is being admitted or compressed. In other respects, the operation of the valves may be automatic. The action of the plates may be aided by the movement of the non-return valve in the suction pipe, or this movement may be used alone for controlling the admission and exhaust valves. Whatever mechanism is employed for controlling the valves, it must act to control the two chambers alternately, inasmuch as they operate alternately.

Where there are more than two combustion chambers, the cycle in each may be so far altered that the products of combustion are not exhausted by the first return of the liquid, but are compressed to provide an elastic cushion to aid (by the energy stored in it) the energy of the combustion in another chamber. Thus, assuming three chambers, while ignition is occurring in A, compressed products are expanding in B, and a fresh charge is being drawn into C. On the return of the liquid, products are being compressed in A; exhaust is occurring in B; and compression of a fresh charge in C, and so on.

It is not essential for the invention, however, that there should be more than one combustion chamber. In this case, the combustible mixture is supplied under pressure, for which purpose a portion of the energy of combustion may serve to compress the charge before it is admitted into the chamber, or to compress air which is subsequently used to propel the mixture into the chamber. The returning liquid then expels the greater part of the products of combustion; and during the final portion of its return it compresses the charge admitted under pressure into the residual products.

The foregoing general statements are elucidated in the official specification by a series of diagrammatic drawings showing sections of pumps, and accessories thereto, operated and constructed according to the invention.

APPLICATIONS FOR LETTERS PATENT.

18,176.—Brown, D. S., jun., and Stinzing, F. C., "Igniting gaseous fuel." Aug. 29.

18,248.—Carpenter, C. C., "Inverted burners for streets." Aug. 31.

18,274.—Tuppstedt, W., "Gas-ranges." Aug. 31.

18,334.—Bird, H., "Automatic discharging scoop for charging gas-retorts." Sept. 1.

18,335.—Williams, P. E., and M'Phee, N., "Discharging machines for gas-retorts." Sept. 1.

18,377.—Kolb, O., "Jet-condensers." Sept. 1.

18,402.—Morison, D. B., "Cooling towers." Sept. 2.

18,466.—Fletcher, Russell, and Co., Ltd., Neil, J., and Fletcher, T. W., "Gas or oil heated radiator." Sept. 3.

18,508.—Luithlen, F., "Illuminating interiors without the production of shadows." Sept. 3.

18,537.—Robson, G., "Gas-cocks." Sept. 3.

18,542.—Belton, J. C., "Syphons for gas-mains." Sept. 4.

18,573.—Chipperfield, W. H., "Compression of gas or air for lamps." Sept. 4.

18,581.—Main, R. B. & A. P., "Gas-regulators for gas-heated steam-radiators." Sept. 4.

18 582.—Main, R. B. & A. P., "Gas-fires." Sept. 4.

18,686.—M'Culloch, J. M'G., "Pumps or meters." Sept. 5.

18,710.—Linsey, W., "Clip for pipes." Sept. 7.

18,716.—Harvey, T. F., "Straining or filtering apparatus for use with water-mains." Sept. 7.

18,741.—Tontet, R. V. G. M. E., "Air-gas generators." Sept. 7.

18,779.—Billington, W. J., "Gas-cocks." Sept. 7.

18,829.—Rodhe, O., "Analyzing gas." Sept. 8.

18,831.—Peyton, E. P., "Packing-pieces for chemical towers." Sept. 8.

18,851.—Compagnie pour la Fabrication des Compteurs et Matériel D'Usines à Gaz, "Gas-meters." Sept. 8.

18,860.—Elton, Sir E. H., and Stephens, R., "Gas lighting and extinguishing apparatus." Sept. 8.

18,861.—Cox, F. J., "Burners." Sept. 8.

18,887.—Helps, G., "Incandescent burners." Sept. 9.

18,898.—Tyler, W. E., "Valves." Sept. 9.

18,901.—Helps, G., "Incandescent burners." Sept. 9.

18,913.—Stevens, J. R., "Gas-burner." Sept. 9.

18,924.—Scott-Snell, C., "Heat-engines." Sept. 9.

18,941.—Brock, J. M., "Gas-stoves." Sept. 9.

18,949.—Anderson, D., and Worsfold, J., "Inverted burner." Sept. 9.

19,013.—Niemann, H., "Gas cut-off." Sept. 10.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Electric Light Failure at Southend.

Sir,—It would appear from a paragraph in your issue of the 15th inst. (p. 739) that on Saturday evening last at Southend-on-Sea for about a quarter-of-an-hour darkness reigned supreme. This is by no means the fact, for the old illuminant (gas) still plays a very prominent part in the lighting of this rapidly-growing borough. Some of the leading tradesmen depend entirely upon it, and a few run the two lights side by side; and in such cases the absence of electricity is really not noticeable. I know one shop in the main thoroughfare where gas is not used; and there I am informed on Saturday evening last the customers who were in the shop at the time of the failure of the electric light were locked in—an indignity to which I certainly should not submit. At the Pier Pavilion, the Maltby Company were stopped in their play, owing to the stage being lighted with electricity. In the auditorium both lights are used.

The following figures will doubtless prove of interest to your readers. The output of gas for the year 1897 was 74,175,500 cubic feet, and for 1907 293,443,200 cubic feet—an increase of 295 per cent. During the same period, the number of consumers has increased from 2266 to 11,589; and 25 miles of main-pipes have been laid. There are 1160 public gas-lamps in the borough; and the pier (south of the pavilion) is lighted by gas, as well as the covered seats and promenade on the extension.

Trusting you will find space in your next issue for this letter.

Southend-on-Sea Gas Company,
Sept. 18, 1908. Jas. T. Randall.

[Only a fortnight ago, on the occasion of the half-yearly meeting of shareholders, we had an opportunity of drawing the attention of readers of the "Journal" to the gratifying dimensions which the output of gas at Southend has reached, and the large number of consumers that are now on the Company's books. We regret if the paragraph to which our correspondent refers should have conveyed any different impression.—Ed. J.G.L.]

WATER CHARGES IN THE CITY.

The following letter on the subject of the Metropolitan Water Board's charges has been addressed to the "Journal" by Mr. W. R. Buckingham, Acting-Secretary, Machinery Users' Association (Incorporated), Nos. 22 & 23, Laurence Pountney Lane, E.C.

The Board are now sending out their demands for water-rate; and concurrently they are serving notices upon persons who have hitherto refrained from signing the agreements which the Board have in many cases sent for the signature of consumers, to the effect that "as the agreement tendered for a combined supply has not been executed and returned, the supply will not be continued under the present conditions after Sept. 30 next."

As these notices are creating great uneasiness, and even alarm, my Council have thought it would allay these feelings if it were pointed out that the Board have admitted that they have no power to enforce these agreements. It is important to bear this fact in mind, because it is only a very limited number of consumers who can derive any benefit from them. They are entirely one-sided in their provisions, as they relieve the Board of obligations which are thrown upon them by their Act, without giving the consumer any privileges that the Act does not give him. The Board suggest that it will relieve the consumer of the expense of altering his fittings; but my Council are advised that in many cases no alteration of the fittings is necessary, and, even where it is otherwise, it is obvious that it would be folly on the part of the consumer to agree to pay an annual charge rather than incur, once and for all time, the expense of altering the fittings. In the cases of a great many of the members of this Association, the annual charge the Board seeks to obtain under the agreement would be much larger for one year than the capital cost of any alteration in the fittings.

To show how exacting the Board are in their demands, I may say that in one case where there are a few weekly tenements supplied from a factory supply-pipe, the Board, in order to compel the consumer to sign the agreement, have refused to accept the scale charge by meter for all the water supplied to the tenements as well as to the factory, in addition to the 5 per cent. upon the rateable value of the tenements which they are entitled to under section 8 of their Act. In this case, the excess charge payable under the proposed agreement would be an annual charge of about £40; and as the tenements are situated a long way from the Board's mains, the cost would be the unusually heavy sum of perhaps £60 or £70. But in ordinary cases the cost would, of course, be far less than this.

It is reported that steps are being taken by ratepayers in the City to ask the Lord Mayor to summon a meeting of protest at the Guildhall against the new scale of charges imposed by the Metropolitan Water Board. The Lord Mayor has been approached upon the subject, and has expressed his willingness to preside at such a meeting if a sufficiently large requisition is presented to him. This requisition is expected to be signed by a considerable number of prominent ratepayers.

A contract has been signed with the Elstree and Boreham Wood Gas Company, for the public lighting for five years of the parish of Elstree. The number of lamps is to be increased from 25 to 35; and the incandescent system is to be installed. The price is to be £2 7s. 6d. per lamp per year. It is intended at an early date to put up other gas-lamps, replacing oil-lamps.

MISCELLANEOUS NEWS.

RATING OF MUNICIPAL AND COMPANY UNDERTAKINGS.

Mr. Wilson Mappin's Remarks at Sheffield.

In the course of his speech to the proprietors at the recent half-yearly meeting, Mr. Wilson Mappin, the new Chairman of the Sheffield United Gaslight Company, made some reference to the difference in the rates paid by the Corporation electricity and other undertakings, and the amount contributed under the same head by the Gas Company; his contention being that the municipal departments were in this respect "treated very leniently." Subsequently the "Sheffield Independent" published the result of an interview with Mr. William Terrey, the General Manager of the Water Department, with the view of showing that there was another side to the question. These remarks were as follows:

First it must be borne in mind that there is one rating authority, outside the Corporation, responsible for the valuation of all undertakings. This was a point which Mr. William Terrey, of the Water Department, made in the course of an interview. Everyone regards Mr. Terrey as an authority on local financial and rating questions. "Is it suggested," Mr. Terrey inquired, "that local and London valuers, appointed by the Assessment Committee of the Board of Guardians, do not apply the same recognized principles of valuation to the Corporation undertakings as to the Gas Company's property?" The basis of assessment, he pointed out, is the net earnings in each case. It is well known that in making a valuation of these large undertakings for rating purposes allowance is made by the valuer for ordinary depreciation and the average cost of renewals. But in the case of electric light undertakings a further deduction is made for "obsolescence or antiquation"—*i. e.*, the replacement of machinery and plant before the average life is exhausted—a legitimate deduction, having regard to the exceptional position of an electric light undertaking compared with gas or water, and generally allowed by expert valuers throughout the kingdom, whether such undertakings are in the hands of municipalities or private companies. It should, therefore, be borne in mind that this extra provision reduces the proportion of the net earnings of an electric light undertaking compared with that of gas, and consequently the lawful rateability. Mr. Wilson Mappin stated that the capital of the three Corporation trading undertakings is over £4,000,000. But the actual capital expenditure is £5,311,323; and the total gross profits of the three concerns amount to £286,719. The amount of rates and taxes paid by the three departments out of each shilling of gross income is ¾d., compared with 1·06d. by the Gas Company, assuming the latter figure is correct; and having regard to the reduced proportion of net earnings of these undertakings compared with the gas concern, the undertakings would appear to be equitably assessed by the outside valuers employed.

Dealing with the Water Department separately, Mr. Terrey pointed out that the capital expended on reservoirs and works is £3,376,915, and the gross profit £125,719, showing a yield on the capital employed of 3·72 per cent.; whereas the capital expended by the Gas Company is £970,355, and the gross profit £89,768, a yield of 9·25 per cent.—or nearly 2½ times the yield per cent. on the amount of capital compared with the water undertaking. Notwithstanding this, it is a curious fact that the amount paid by the Water Department in rates and taxes out of each shilling of income is 1·06d., exactly the same amount as Mr. Wilson Mappin states is paid by the Gas Company. The storage reservoirs are situated in outlying parishes; and independent expert valuers are appointed by the several rating authorities. Though the works are outside the rateability for Sheffield, they are assessed to the fullest possible extent, and the rates paid thereupon out of the water revenue. The outside authorities, equally with the central rating authority, can be fully trusted to see that the Corporation do not escape the payment of a single shilling that can be legitimately charged. The Corporation, like other ratepayers, have to look after their own interests; and not infrequently the valuation of the professional valuers employed by the Assessment Committee is challenged.

ARBITRATION IN TRADE DISPUTES.

A Standing Court of Arbitration to be Set Up.

Last week the President of the Board of Trade caused to be issued particulars of a new scheme of conciliation in trade disputes, under which he proposes to have a Standing Court of Arbitration, with instructions to sit whenever required. The proposal is explained in the following "Memorandum" sent to Chambers of Commerce and Employers' and Workmen's Associations.

(1) Under the Conciliation Act of 1896, the Board of Trade has power to appoint a conciliator in trade disputes and an arbitrator at the request of both parties. These slender means of intervention have been employed in cases where opportunity has offered; and the work of the Department in this sphere has considerably increased of recent years. In 1905 the Board of Trade intervened in 14 disputes, and settled them all; in 1906 they intervened in 20 cases, and settled 16; in 1907 they intervened in 39 cases, and settled 32; while during the first eight months of the present year no fewer than 47 cases of intervention have occurred, of which 35 have been already settled, while some of the remainder are still being dealt with.

(2) It is not proposed to curtail or replace any of the existing functions or practices under the Conciliation Act, nor in any respect to depart from its voluntary and permissive character. The good offices of the Department will still be available to all in industrial circles for the settlement of disputes whenever opportunity offers; single arbitrators and conciliators will still be appointed whenever desired; special interventions will still be undertaken in special cases; and no element of compulsion will enter into any of these proceedings. But the time has now arrived when the scale of these operations deserves, and indeed requires, the creation of some more formal and permanent machinery; and, with a view to consolidating, expanding, and popularizing the working of the Conciliation Act, I propose to set up a Standing Court of Arbitration.

(3) The Court, which will sit wherever required, will be composed of three (or five) members, according to the wishes of the parties, with fees and expenses to members of the Court and to the Chairman during sittings. The Court will be nominated by the Board of Trade from three panels. The first panel—of Chairmen—will comprise persons of eminence and impartiality. The second will be formed of persons who, while preserving an impartial mind in regard to the particular dispute, are nevertheless drawn from the "employer class." The third panel will be formed of persons similarly drawn from the class of workmen and trade unionists.

It is hoped that this composition will remove from the Court the reproach which workmen have sometimes brought against individual conciliators and arbitrators—that, however fair they mean to be, they do not intimately understand the position of the manual labourer. It is believed that by the appointment of two arbitrators selected from the employers' panel and two from the workmen's panel in difficult cases—thus constituting a court of five instead of three persons—the decisions of the Court would be rendered more authoritative, especially to the workmen, who, according to the information of the Board of Trade, are more ready to submit to the judgment of two of their representatives than of one. As the *personnel* of the Court would be constantly varied, there would be no danger of the Court itself becoming unpopular with either class in consequence of any particular decision; there would be no difficulty in choosing members quite unconnected with the case in dispute, and no inconvenient labour would be imposed upon anyone who consented to serve on the panels. Lastly, in order that the peculiar conditions of any trade may be fully explained to the Court, Technical Assessors may be appointed by the Board of Trade at the request of the Court or of the parties to assist in the deliberations, but without any right to vote.

(4) The state of public opinion upon the general question of arbitration in trade disputes may be very conveniently tested by such a voluntary arrangement. Careful inquiry through various channels open to the Board of Trade justifies the expectation that the plan would not be unwelcome in industrial circles. The Court will only be called into being if, and in proportion as, it is actually wanted. No fresh legislation is necessary.

(5) Steps will now be taken to form the respective panels.

ELECTRIC LIGHT FAILURES.

A Large One at Geneva.

A correspondent, writing from the Continent last Thursday, says: You will probably have read of the failure of the electric light in Geneva last Monday night, when, according to one report, about 150,000 incandescent and 500 arc lamps went out. Fortunately, the incandescent gas system is in use in the side streets as well as upon the principal bridge, or things might have been worse. As it was, the Kursaal (the outside of which is illuminated like the buildings at the White City), the theatre, and other places of amusement were in sudden darkness. Curiously enough, as I was crossing the Pont du Mont Blanc, which is in a direct line with the railway station, I noticed that the arc lamp standards also carried two double-burner incandescent gas-lamps, which I considered a good idea. I little thought that half-an-hour later they would be found valuable. I was on my way to the Cathedral to hear an organ recital; and at the outset of about the third piece, just as a lady vocalist was warming up to her work, out went every light. Organist and vocalist struggled on for a time by the aid of a vesta, but eventually gave up. People began to rise from their seats, when an official of the Cathedral asked them to remain seated as lamps would be brought. These came, and after a delay of ten minutes the recital proceeded. By about 9.30 (half-an-hour after the collapse), the electric light was restored. On returning to the hotel, I was mentioning the occurrence; and the *concierge* said it had been the same all over the town. As play was in full swing at the Kursaal and elsewhere, the keepers of the tables had to look after their money in the dark. In addition to the play, there was a variety entertainment going on in the adjoining theatre. I saw by the papers next morning that the accident was attributed to a short-circuit. When I got round to Martigny on Tuesday night, I was mentioning the fact at the hotel; and marvellous to relate, while dinner was in progress, every electric light went out, and candles had to be brought in. It was restored, however, after a few minutes. This was something purely local, as the porter said that the lamps were all right in the town. The Geneva affair, however, was serious.

In the South Metropolitan Electric Company's District.

Private residents and shopkeepers in the south part of London—reaching from Lee and Blackheath to Sydenham—who have their premises lighted by electricity were put to considerable inconvenience through the failure of the electric light last Saturday night. The collapse, it is said, was due to "the breakdown of a dynamo at the station." The shopkeepers who patronize electricity especially suffered—the stoppage of current occurring just as the week's business was at high-water mark. Naturally there was a rush for candles and other portable lights to enable business to continue; and householders were set to work trimming their stand-by lamps. Happy were those who had not completely evicted the ever-ready and reliable gas. The duration of the discontinuance of the current was about five-and-twenty minutes; but to irate tradesmen, it appeared to be a longer five-and-twenty minutes than any other similar period during the evening.

Coalite for Russia.—It is stated that the Coalite Company, Limited, have been authorized by the Minister of Finance to open in Russia a subsidiary concern, the capital of which (£25,000) will be found by the parent Company.

BURSLEM ELECTRICITY UNDERTAKING.

Some Interesting Points.

A Local Government Board inquiry was recently held by Mr. H. R. Hooper into an application by the Burslem Town Council for sanction to borrow £12,000 to enable them to wipe off expenditure already incurred, and to provide for further estimated outlay.

The Town Clerk (Mr. A. Ellis) said the Council desired the longest period the Board would allow for the repayment of the loan. He explained that at March 31 last the excess expenditure was £6618; and since that date further sums amounting to £2099 had been spent. The Electric Lighting Committee had been fully aware that they had exceeded the amount for which sanction had been obtained; but the increase in the demand had come so quickly that they hesitated to apply for a further sanction, because they did not know what amount they might require. They also thought it better to wait for a few months rather than make two applications at short intervals.

The Inspector pointed out that there was the question of federation to be considered; and he thought it would be as well if they could limit any application for further expenditure so as to meet the requirements up to the time when this would come about. He asked what had been the financial results of the undertaking so far; and Mr. A. Bremner, the Electrical Engineer, replied that for the first six months, to March 31, 1906, there was a loss of £197, for the nine months to Dec. 31, 1906, the loss was £461, and for the year to Dec. 31 last, a profit was made of £235. The Inspector said he did not see that they had made any profit in Burslem—at any rate, there was no reserve fund. The capital expenditure and returns certainly so far had involved a loss. Mr. Bremner said that they could not expect to earn revenue straight away; they had to cultivate it. The Town Clerk: Your remarks do not encourage people to go in for electricity. The Inspector: It is not that, but I want to understand the undertaking as far as I possibly can; and therefore one has to know the weak spots as well as the strongest.

An interesting discussion next took place upon the question of charges made for current. The Inspector said he noticed the charges ran down very low; and he inquired whether the Engineer knew of any undertaking equal to that at Burslem in output, where electricity was sold at ½d. per unit. Mr. Bremner replied that he did not, nor could he give the name of one selling at 1d. with such an output and making a profit. At Burslem a contract at ½d. per unit had been entered into with one firm, for ten years, with no minimum guarantee. The following instructive colloquy then took place.

The Inspector: Without any guarantee, ordinary consumption at ½d.! When your power load overlaps your lighting load and your present fixed charge is 1·3d. per unit for interest and capital alone, I should like you to show me where the ½d. is going to be a profit to the Corporation. Mind you, not only that, but the reserve fund that must be built up somehow?

Mr. Bremner: We do not sell the bulk of our current at ½d.

The unfortunate position is that the power load overlaps the lighting load; and therefore the plant that is needed for power surely has to pay, and must be charged with, its proper proportion of fixed charges in exactly the same way as the other current. You may regard the Corporation as ordinary consumers; and you charge them 3d. per unit. Subsequently the Inspector said that even at the charge of ¾d. or 1d., he wanted to know how it could pay. If they had an overlapping load, and at present it was costing the Corporation over 2d. a unit, surely somebody had got to make it up. Was it the private consumer at 5d.?—Supposing we had not any power load at all, the station would be shut up for eight hours a day.

And everything would be reduced. Your plant, your capital expenditure, and your staff would be reduced?—I do not think the plant would be reduced.

How can you supply electricity at that price when, for fixed charges alone, it is costing you 1·3d. for every unit?—I contend that you are not entitled to charge the whole of the repayments and interest, nor wages, to the units that are sold during the day.

The undertaking has been running three years, and there is no profit yet, is there?—Well, there would be less if we had not had power.

I am not suggesting that power has not helped many undertakings. What I am questioning is where your profit comes in selling current at ¾d. and ½d. per unit. I do not see with your present small installation how you can make contracts at that price?—At the present moment we do not sell at that price.

Then why make the contracts? The price is very low, is it not, having regard to the fact that there are no profits yet?—I must admit that the price is low; but I have no hesitation in saying we can earn a profit on the day load at that figure.

The public lighting and the private consumer would have to pay in order that the manufacturer can get a low price for his current. Is not that so?—Certainly not; I do not agree that the price charged for lighting in Burslem is high—5d. per unit.

It is a poor place, is it not?—I do not say so.

Take the number of houses and the rateable value, it has a low rateable value having regard to other towns. You would not compare it with Eastbourne and other towns?—It is an exceptional district, because the works are in the town. The works themselves form the streets; and therefore the rateable value must be fairly high.

I am taking the inhabited houses?—The inhabited houses are not of high rateable value.

I cannot see the connection between 1d. and ¾d. and ½d. for power, and 3d. for public lighting. Do you know whether the 3d. per unit is a high charge or a low charge for arc lighting?—A fair charge; it includes the trimming and carbons and things.

You are making a profit on public lighting, are you?—We hope so.

Is it the usual policy to make a profit out of public lighting?—Yes; I think it is.

Surely that is simply that the profit you make out of public lighting is an additional contribution to the rate-in-aid?—The Electric Lighting Committee look upon public lighting as the greatest advertisement to the concern.

That has nothing to do with it. The point is that, with the public lighting at the present price, the profit being made on the Electricity Department is practically a profit which the ratepayers have to pay, and that in practice is nothing more nor less than a rate-in-aid to the undertaking.

The Town Clerk: That is leaving out of consideration what they would have to pay for another illuminant?

The Inspector: Quite so; but they have a monopoly in that respect, because they have a gas undertaking.

Finally, the Inspector said that it had been stated in evidence that a profit was made out of the electric lighting; and it was not difficult to understand that at a charge of 3d. per unit for public lighting it would be so. It was a very high charge; and that was why he had asked for particulars about it.

OTTOMAN GAS COMPANY, LIMITED.

An Increased Dividend.

The Ordinary General Meeting of this Company was held on Tuesday last, at the London Offices, No. 9, Queen Street Place, E.C.—Colonel JAMES LE GEYT DANIELL in the chair.

The SECRETARY (Mr. Thomas Guyatt) read the notice convening the meeting, the certificate of the Auditors, and the minutes of the previous meeting; and the report and accounts were taken as read. The report stated that the gas-rental for the half year to June 30 amounted to £15,232, compared with £14,802 for the corresponding period of 1907; while the net profit was £3755, against £3187. The amount standing at the credit of profit and loss account was £12,825.

The CHAIRMAN, in moving the adoption of the report and accounts, remarked that the Directors were extremely pleased to meet the shareholders present, because they were able to lay before them a position of affairs which the Company had never hitherto reached. He did not, however, propose to go much into the details of the figures, because they spoke for themselves. In the corresponding half year of 1907, the profit was considerably larger than in 1906; and therefore the shareholders might not unreasonably have expected—in view of the fact that the price of coal had gone up so much—to see that the profit was no greater than it was twelve months ago. But this was not the case, because, as stated in the report, the net profit was £3755, as compared with £3187 in the first half of last year. It would be seen from the accounts that coal had cost £6061, whereas for the same period of 1907 the figure under this head was £5329; the average price per ton having been 19s. 2d., as against 17s. 11d. There were 6325 tons carbonized, compared with 5954 tons in 1907, or 371 tons more; and they sold £15,232 worth of gas, against £14,802 worth. Of the amount he had named, private lighting had contributed £11,169, as compared with £10,813 last year, or an increase of £356. The number of new consumers added during the period under review was 204; and the increase that was recorded twelve months ago was just about the same. They had also increased to a very small extent the number of public lamps. These results showed that the business was progressing gradually. Of course, there were other interests that competed with them; but the Company managed for all that to hold their own. He did not know that there were any other points to mention; but when the shareholders came to look down the assets, and saw what they were after deducting the capital investment on the works, he felt sure they would agree with him that the position of the Company was an extremely sound one.

Mr. STEPHENSON R. CLARKE seconded the motion.

Mr. J. TYSOE remarked that criticism of accounts was supposed to be very useful; but he thought on this occasion no criticism was possible. The accounts and the results appeared to be excellent. There were, however, two questions he would like to ask. At two or three meetings mention had been made of coal obtained locally; but this time no reference to the matter was to be found in the report, nor had the Chairman alluded to it in his speech. He did not know whether there was anything to be said on the subject. It had been hoped that the use of this local coal would prove a great benefit to the Company; and he would be glad to know whether anything had transpired to alter this view. Then with regard to the item of "Depreciation, renewals, and repairs," he would like to know whether this was the actual amount spent in renewals and repairs, or whether there was a percentage beyond what was spent put down to depreciation.

The CHAIRMAN said that the item was made up of amounts actually spent; but it included £1300 for the amortizement account as well.

Mr. TYSOE: It seemed rather heavy for general repairs.

The CHAIRMAN pointed out that the amounts were always put in after consultation with the Auditors. With regard to the local coal he said he must apologize for having omitted all reference to the matter, because it was one of considerable interest. All expectations in connection with the coal had been quite realized; and they felt the benefit of it in the price they paid for coal. What the Directors had done was to take a fair proportion of the coal; and arrangements on this basis covering next year were then being made. The price, whether of Durham or of local coal, he thought would be quite satisfactory to the shareholders when they saw the result.

The resolution was carried unanimously.

The CHAIRMAN proposed, and Mr. H. WARD ANDREWS seconded, the payment of dividends for the half year at the rate of 7 per cent. per annum on the preference shares, less income-tax, and at the rate of 8 per cent. per annum on the ordinary shares, tax free; and this was agreed to.

The CHAIRMAN, in moving a vote of thanks to the Secretary and the Engineer (Mr. John Gandon) and staff in Smyrna, remarked that it was always gratifying to the officials to know that their services had been referred to at the shareholders' meetings

Mr. TYSOE seconded the vote, which was unanimously accorded.

The SECRETARY returned thanks for Mr. Gandon and himself.

Mr. A. W. OKE proposed a vote of thanks to the Chairman and Directors. The shareholders were, he said, that day in the satisfactory position of receiving an increase in the dividend which made it (as it was paid tax free) £8 8s. per cent. It was gratifying to feel that this was

the result of the care which the Directors had exercised in the selection of their officers and in the policy they had pursued in regard to the business generally—the attention that had been devoted to the consumers, and the building-up of the reserves which now appeared in the balance-sheet, and which secured the prosperity of the Company. Certainly the policy that had been pursued in the past had been amply justified.

Mr. A. W. COOPER seconded, and remarked that, as one of the Auditors, he could echo what Mr. Oke had said, and certify to the sound and substantial position the Company were in financially.

The vote was accorded; and with the CHAIRMAN'S acknowledgment the proceedings terminated.

Extraordinary Meeting.

An Extraordinary General Meeting was then held, for the purpose of rescinding Article 81 of the Articles of Association, and substituting another for it. The article to be rescinded reads: "The number of Directors shall from time to time be determined by an extaordinary general meeting; but until any other number is so determined, there shall be seven Directors." The article to be substituted is as follows: "That the number of Directors shall from time to time be determined by an extraordinary general meeting; but until any other number is so determined, there shall be five Directors."

The CHAIRMAN, in moving a resolution to this effect, remarked that when the affairs of the Company were not so prosperous as was the case now, the Directors, from motives of economy, reduced their number from seven to five. As any alterations in the Articles of Association must be made by resolution of extraordinary general meetings, to put the matter absolutely in order, the present resolution was proposed. The Board thought five Directors quite enough to work a business of this kind. No change was suggested in the article which fixed the maximum remuneration of the Directors at £1050, and the minimum at £700.

Mr. A. M. PADDON seconded, and pointed out that when the Company was formed the maximum remuneration of the Board was fixed at the figure at which it remained now—£1050 a year. Therefore the Directors were then entitled to draw this sum, with an output of gas that could not have been more than 1 or 2 million feet; and under the resolution now before the meeting, the Board would be entitled to the same amount, with an output of gas perhaps a hundred times as great as in the early days of the Company. For many years, the Directors who were regenerating the Company and bringing it to its present position had been accepting less remuneration than the minimum amount that was named in the articles.

A brief discussion followed, in which Mr. W. A. Hounsom and Mr. A. W. Oke took part.

Mr. TYSOE: Is it understood that when the number of Directors is reduced to five they can divide £1050?

Mr. PADDON: They have that power now.

The resolution was then carried unanimously.

COVENTRY'S NEW WATER SUPPLY.

Inauguration Ceremony.

Coventry has carried through successfully the scheme for increasing the city's water supply, by arrangement with its near neighbours of Birmingham. The project which was inaugurated last Thursday has been forced upon the "City of Spires" by the rapidity with which it has grown and is still growing. A community which in a few years has added to its population some thirty thousand and more obviously cannot be content with existing facilities. It must have an eye to the future.

With a full sense of their responsibilities, the Coventry Water-Works Committee, with the Deputy-Mayor, Alderman A. H. Drinkwater, at their head, have risen to the occasion nobly; and their enterprise has found practical sympathy and support from the Water Committee of the Birmingham Corporation, who from the very commencement have facilitated to the utmost of their power the efforts of Coventry to provide an augmented supply. When the great Midland Capital was in a position to avail itself of the Elan Valley service, there was no longer the same necessity for preserving the supply at Shustoke; so that what was Coventry's gain was at the same time Birmingham's opportunity. Nothing could have been better devised. Coventry in its agreement with Birmingham undertakes to receive from the authority of the latter city a minimum quantity of 840,000 gallons per day. Coventry will pay to Birmingham £5000 yearly for the water taken. The new supply is obtained from the watershed of the Bourne River; and having been filtered at Whitacre, it is pumped through twelve miles of main from Shustoke to the reservoirs of Coundon. The supply may be increased to 2 million gallons daily if necessary. In the event of the Bourne water ever becoming contaminated or impure in any way, the Coventry Corporation have power to insist on being supplied with Welsh water; so that the interests of the city are safeguarded in every respect. The new main is 20 inches in diameter from Whitacre to Meriden, and 16 inches for the remainder of the distance. It was in October last that the work of putting down the main was begun; and the cost of the scheme to Coventry works out at £81,000, which is to include the provision of a new covered tank at Coundon. The effect of this enterprise will be to increase Coventry's supply of water to 4 million gallons per day; and it is calculated that even with the City's rapid expansion it is now amply provided for even for more than half-a-century.

It was a thoroughly representative company that assembled at Thursday's interesting ceremony of tapping the new source of supply. The Lord Mayor of Birmingham (Councillor H. J. Sayer) attended, as did also Alderman Beale (the Chairman of the Water Committee). The Coventry Corporation were represented by the Mayor (Alderman W. Lee), the Deputy-Mayor (Alderman A. H. Drinkwater), and a number of aldermen and councillors. There were also present Mr. A. E. Woodley Mason, M.P. for Coventry, Mr. Charles Hawksley (of the firm

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of Messrs. T. & C. Hawksley, the Consulting Engineers of the scheme), Mr. T. J. Davies, and Mr. G. F. Ball (of Messrs. Davies, Ball, and Co., Contractors), in addition to representatives of the Sheepbridge Coal and Iron Company, the Holwell Iron Company, and the Stanton Iron Works, contracting firms.

The Mayor of Coventry (Alderman W. Lee), after the usual introductions had taken place, proceeded to perform the interesting duty of turning on the supply, which he did by operating a valve in the small meter-house. A short speech was delivered by His Worship, in the course of which he remarked that the rapid increase in population and the growth of the city's industries had taxed the resources of the Water-Works Committee. But, fortunately, it came to the knowledge of the Town Clerk that it might be possible to arrange terms with Birmingham by which a supply could be obtained; and he was confident it would prove all they could wish for in every respect. They were successful in their negotiations with Birmingham; and also in the negotiations necessary to secure the Act of Parliament. Considering the Act received the Royal Assent only in August of last year, their City Engineer and the Engineer of the scheme, Mr. Hawksley, must have been pretty smart to have enabled him to open the works that day. He then declared the new and additional water supply open.

The water having been turned on, the company proceeded to a marquee on the grounds, where luncheon was served; the Mayor of Coventry presiding.

The toast of "Success to the New Water Supply" was proposed by His Worship, who, after expressing their gratitude to the Lord Mayor of Birmingham for his presence, proceeded to observe that the day's ceremony marked the consummation of the desire of the Water-Works Committee of Coventry. They recognized that there was no commodity more necessary to human life than water. It was in 1891 that the Municipality of Birmingham entered upon a bold and magnificent scheme of bringing water from Wales, and to-day Coventry was bound up in this great enterprise. They were intimately concerned now in Birmingham's gigantic water undertaking; and as long as there was water for Birmingham, there would be water for Coventry. In reviewing the history of the Coventry water undertaking, he said the first water-works in Coventry were opened in 1847, when the population was about 36,000. The next supply, that from Whitley, was inaugurated in 1895, when the population was about 53,000. That day they had opened this additional supply with the population of the city estimated at 93,000. The Water-Works Committee were not unmindful of the fact that the present supplies at Spon End and Whitley were obtained from deep wells; but though these had yielded abundantly for many years, they could not be expected to go on for ever. When the question of obtaining an additional supply arose, Mr. Hawksley and Professor Lapworth were consulted; and they indicated several sources from which a supply could be obtained. These, however, would have entailed the erection of many pumping-stations and enormous outlay. Then it was intimated that Birmingham had more water than they needed; and the result of the negotiations was being celebrated that day. They had now a sufficient supply of water for all purposes in Coventry; and in advertising Coventry's advantages a point should be made of its water supply. The Corporation of Birmingham had undertaken to supply them for a period of at least sixty years; and the presence of members of that body was a guarantee that the arrangement would be faithfully and honourably kept.

The Deputy-Mayor (Alderman A. H. Drinkwater), in reply, mentioned the difficulties that had to be faced in certain districts in the past on account of dry weather and insufficient pressure, and said that during last year the daily average consumption of water for all purposes was 1,912,000 gallons—this representing nearly the whole volume of their hitherto available supply. The carrying out of the new scheme had placed them in the position of having now a supply well in advance of their requirements. The total estimated cost of the works was £81,000, of which £41,600 was for the construction of the line of pipes, and £32,400 for the construction of a new service reservoir adjacent to the one at Coundon.

The Mayor of Coventry was then presented with a silver cup on behalf of the Council, as a memento of the occasion, and Alderman Drinkwater received a similar gift from Mr. Charles Hawksley, on behalf of his firm.

Alderman Beale, on behalf of the Birmingham Water Committee, said it was no formal interest that they had taken in this scheme. From start to finish they had been anxious to do all they could to bring the project to a successful conclusion, and one that would be satisfactory to both parties. In Birmingham they prided themselves on being able to get things through smartly; but he was really surprised at the way in which this scheme had been completed. Two years ago they had no idea that Coventry would want any water from them. He hoped they would take as much water as they could, as it would be for the benefit of the Birmingham ratepayers. The quality of the water was declared by experts to be excellent; and it was to the interest of Birmingham to keep it as pure as possible, because they might want it some day for themselves. He also referred to the valuable help rendered in the early negotiations by the late Alderman Lawley Parker; and he also acknowledged the help of Mr. Miller.

Mr. A. E. W. Mason, M.P., having spoken of the cordiality with which the two authorities of Coventry and Birmingham had worked in this matter, the proceedings terminated.

Foremen's Strike at Milan Gas-Works.—Last week we reported a strike of foremen and under-foremen at the Union des Gaz Company's works at Milan; their demand being for increased pay so as more definitely to mark their rate over that of ordinary employees. We learn from the Milan papers that the parties to the dispute have been brought together in the presence of the Syndic (Sig. Ponti) and Assessors (Sigg. Morpurgo and Rusconi). After a deferred meeting to the Camera del Lavoro, a Commission of Arbitration was agreed upon; but the foremen authorized their representatives to insist upon their rate of pay being fixed, not by the Arbitrators, but by Sig. Ing. Lacombe, the Engineer and General Manager of the Company's works in Milan.

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NOTES FROM SCOTLAND.

From Our Own Correspondent. *Saturday.*

The resignation of Mr. W. Ewing of his post of Engineer and Manager of the Greenock Corporation Gas Department is a subject which can only be referred to with regret. There is so much mystery about it—neither the Corporation nor Mr. Ewing having as yet made public the letter of resignation, nor indicated its terms—that the situation cannot be gauged; and therefore comment is largely precluded. It is known that for some years Mr. Ewing has not been on good terms with some members of his Committee; but it is also known that by other members of the Committee he has all along been looked upon as a most admirable Manager. Those who had Mr. Ewing's interests at heart hoped that, given time and a continuance of his successful management of the undertaking, matters between him and those who did not see eye to eye with him would come right. The working of the past year has, however, given things a wrong turn—and the result is Mr. Ewing's resignation. It was mentioned in these Notes on Aug. 18 that there was a deficit on the year's working of £2755, and that a Sub-Committee had been appointed to consider the balance-sheet and the Manager's report upon the deficit. Neither the balance-sheet, nor the report of the Manager, nor of the Sub-Committee have been made public. Indeed, the Town Council have dealt in a very secretive way with the situation, as will be judged by the account given of their proceedings at the meeting this week, at which they considered the finances of the burgh. Mr. Forbes, the Convener of the Gas Committee, moved approval of the minutes of the Committee, and said it would be noticed that the price of gas was to be raised by 2d. per 1000 cubic feet. At the beginning of the year they had a balance of £3046; but the Corporation urged that this sum should be used during the year. The wisdom or unwisdom of such a course might be open to dispute; but he might say it was actuated by a desire to avoid any additional burden on the community at the time, and they hoped that with an increased consumption, and probably an improved market in residuals, they would be able to come out with a small balance on the right side. Unfortunately, instead of having a surplus, they found they had a deficit of £2755, a large portion of which was to be accounted for in the extraordinary number of new meters that required to be placed in many houses, and in the increased price of coal. To meet the deficiency they proposed to put 2d. per 1000 cubic feet on the price of gas, and also to appropriate the £1955 in the reserve fund; and by exercising every economy they hoped to close the year without any deficiency. Members would also observe that a letter had been received from Mr. Ewing, the Gas Manager, resigning his position. Mr. Taylor, in seconding, said the members had all tried their best; and if expectations with regard to finances had not been realized, the Committee could not blame themselves, and they could only hope, in the interests of the community, that a better state of things would arise during the next year or two. The resignation of the Manager was a question that need not be referred to, as it was to come up before the Law and Finance Committee. With regard to taking the reserve fund, he disapproved of that. The motion seems to have been adopted, though the report before me does not say so, but goes on to state that "at a meeting of the Law and Finance Committee held later in the afternoon, the resignation of the Gas Manager was accepted; and it was remitted to the Gas Committee to make the necessary arrangements thereanent." In these sentences there is not much taking of the public into confidence, and so, not having been consulted, it may be better not to hazard any opinions as to the situation until we get more enlightenment upon it. There is a good deal of correspondence in the local Press, in which favour lies with Mr. Ewing, as does also the views of the editor of the local newspaper I have seen. But whatever may be the reason for Mr. Ewing's resignation, we know his department was by no means alone in the misfortune of having a deficit on their working last year.

The question of the valuation of the undertaking of the Edinburgh and Leith Gas Commissioners is being raised this year upon more than one point. It was before the Valuation Court in Leith on Tuesday, and has still to be heard by the Valuation Court in Edinburgh. In Leith, the Commissioners, through their Clerk—Mr. J. M'G. Jack, S.S.C.—sought to have the valuation of £4938, which had been fixed by the Burgh Assessor, reduced to £2939. In support of their appeal, Mr. J. Duncan Millar, advocate, explained that the undertaking lay in the burghs of Edinburgh and Leith and the county of Midlothian, and that the practice hitherto had been that the Assessor in Edinburgh made up the valuation, and communicated the figures he had arrived at to the other two Assessors; but that this year the Assessor for Leith did not accept the figures submitted to him. The two chief points of difference were whether there was to be a deduction from gross revenue of the whole expenses of management, as has hitherto been the practice, or whether the deduction should be 6-10ths, the remaining 4-10ths to be included in the net valuation assessable; and whether, in the allocation of annual value against capital, the value of the ground occupied by the mains and pipes belonging to the Commissioners was to be included in the total capital amount for the purposes of the allocation of revenue against capital. If the total capital of the undertaking, Counsel said, were to have included in it the value of the ground occupied by the pipes in the streets, it would be increased by a very large amount. If the value of £37,000 were put upon the ground, as suggested by the Assessor for Leith, there would be an additional assessment upon a sum of £2600. The point was one of considerable delicacy, and Counsel expressed the willingness of the Gas Commissioners to withdraw the appeal, in order that there might be an opportunity of arriving at an agreement or compromise with the Assessors, which there was every prospect of their being able to do—the valuation of the undertaking to be meantime made upon the same basis as last year. The Valuation Court were prepared to accept this proposal if the Assessor agreed; but he stated his opinion to be that Leith had not got its just share of the gross assessment of the gas undertaking. He wished the case to go on, so that they might get the opinion of the Court of Session Judges, on appeal, as to whether his contention

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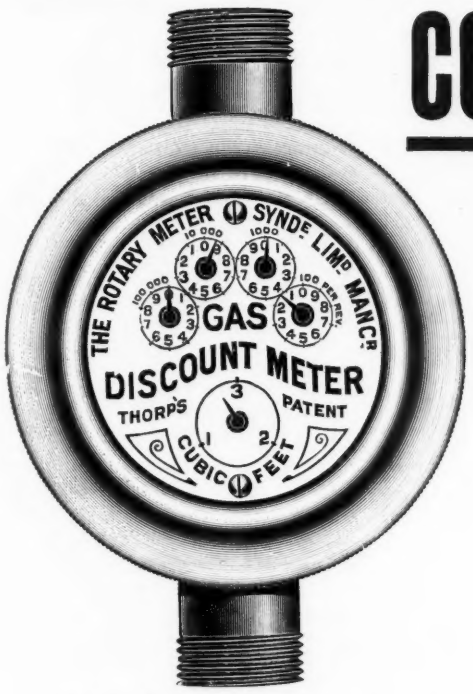
or that of the Gas Commissioners was really the right one. The Court accordingly dismissed the appeal of the Commissioners, and fixed the valuation at £4938.

I mentioned a week or two ago that H.M.S. *Rattler*, in a cruise from Greenock to the Isle of Man and back, was driven by a suction gas-engine, and that the mode of propulsion gave satisfaction. Last week she sailed again, under the same power, from Greenock for Oban and back. When off the coast of Arran, she was visited by Prince Arthur of Connaught, to whom the equipment of the engine-room was explained by Mr. Andrew May, of Messrs. William Beardmore and Co. Next day the vessel, on her way to Oban, encountered terrific weather off the Mull of Cantyre and in the Sound of Jura. This, it is reported, was the first time that a gas-engine had been thoroughly tested in a heavy seaway; and the general working realized the expectations of the engineer officers. The return voyage from Oban was accomplished between the hours of 5 a.m. and 11 p.m.

At the annual meeting of the proprietors of the St. Andrews Gas Company last week—ex-Bailie Aikman presiding—the report of the Directors for the year ending Aug. 31, showed that there had been an increase all round; the gas made having been 1,715,000 cubic feet more than in the previous year. The Chairman said it would be evident to them all that the Company was still progressing; the results of the year they had just finished being the best on record. After paying an interim dividend, they had in hand £1867. For this very satisfactory state of matters they were greatly indebted to their Manager, Mr. Hall, and his staff. The report was adopted, and a final dividend of 30s. per share was declared; making £3 for the year. A debt of £300 was cleared off, and the price of gas was reduced from 3s. 4d. to 3s. 2d. per 1000 cubic feet.

The Corporation of Dunfermline have continued the prices of gas at the same figures as last year—viz., 2s. 6d. per 1000 cubic feet to ordinary consumers, for public lighting, and for cooking and heating; 3s. 1d. for gas consumed through prepayment meters; and 1s. 9d. for gas consumed in gas-engines. This has been done in accordance with estimates prepared by the Engineer—Mr. A. Waddell—in which a make of gas of over 118 million cubic feet is calculated upon, with an allowance of 5½ million cubic feet for unaccounted-for gas. The total revenue is estimated at £18,693, and the expenditure at £18,495; leaving a credit balance of £198. The subject of street lighting by high-pressure gas was also before the Council. The minutes of the Lighting Committee narrated that they had received a report from the Inspector of Lighting, in which it was stated that the Council, a few years ago, after an experiment had been made to show how and at what cost high-pressure lighting could be adopted for High Street, Bridge Street, and Chalmers Street, definitely decided against the system; their verdict being arrived at principally owing to the fact that, for high-pressure lighting, a special gas-main would be required. Since then improvements had been made in the system, although in its main points it was the same as that experimented on before. The principal points of improvement were: (1) Submitting the gas to higher pressure than before, and the utilization of a gas-engine to give the requisite pressure; and (2) a greatly improved lantern, designed to get the maximum possible light out of the gas. The compressor at the last experiment gave a pressure of about 10 inches; whereas the 1908 system gave a pressure of 54 inches. An ordinary flat-flame burner, burning 3400 hours a year, used 15,350 cubic feet of gas, an upright incandescent burner 11,737 cubic feet, an inverted incandescent burner, as in Woodhead Street, 13,600 cubic feet, and a 1908 pattern pressure light (smallest size), 27,200 cubic feet. The high-pressure system would give a light of 500-candle power; whereas the inverted lights in Woodhead Street gave only 125 candles each. In other words, the high-pressure lamp gave 60-candle power light for every foot of gas consumed, the inverted lights 31 candles per foot, and the upright incandescent lights 17·5 candles. There was, therefore, no comparison between the results of the lamps; the high-pressure giving by far the best result from the gas used. It remained, then, only a matter of cost. He estimated that the cost of installing a high-pressure system would be £240, in addition to which there would be an outlay of £95 for 20 lanterns. The consumption of gas would be 453,600 cubic feet, at 2s. 6d. per 1000 cubic feet, £56 14s. Under the ordinary system, consuming 272,000 cubic feet, the cost was £34. If the high-pressure system were adopted, the annual cost to the burgh would be £71; under the ordinary system it is £38. The high-pressure light would therefore mean an additional £33, *plus* part of the time of a man looking after the engine. The Lighting Committee (one member dissenting) agreed to recommend the adoption of high-pressure lighting in the area reported upon; and that 100 of the lamps in other streets, having flat-flame burners, should have inverted incandescent burners substituted, at a probable cost of £160. The Council adopted the latter proposal, but remitted the question of high-pressure lighting back to the Committee for consultation along with the Gas Committee. This consultation has taken place. At it the members of the Gas Committee are said to have argued that the expense would not be justified. The Joint Committee, however, in order to improve the lighting of the town, agreed to recommend the Council to sanction the provision of about twenty double and triple incandescent inverted lamps, the double lamps to give a light of 250 candles, and the triple lamps of 375 candles each.

Bailie Thomson, the Convener of the Finance Committee of the Arbroath Town Council, presented the annual accounts to the Corporation on Monday. They received for gas sold £14,272, which constituted a record, for it was the largest sum ever received for gas in the burgh. They received for residual products £3547, which was also a record sum. Including interest, rents, &c., their total revenue was £17,918. The working expenses amounted to £12,488, which left a balance of £5430. To this had to be added the balance in hand at the beginning of the year, £712—making, in all, £6142, from which there was paid annuities £1339, and interest on loans £691. There was carried to sinking fund £575, and to contingency and depreciation accounts, for ordinary renewals £1257, and for extraordinary damage £1784. He might explain that no sum was ever set aside for damage before, and that the £1784 was put by to pay the £1283 damages paid in respect of the gas explosion last winter, while the remaining £500



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was carried forward. This £500 had been earmarked, so that it would not be used for any other purpose. There was also paid the usual amount of £250 to the Harbour Trustees; and there was a balance left of £247. This showed excellent results, especially when they considered the extraordinary expenditure which had to be met last year. An annuity of £5 12s. had been redeemed out of the sinking fund, at a cost of £162, and a loan of £450 had been repaid; and there was a balance remaining in the sinking fund of £182. From the contingency and depreciation fund, £1257 had been applied in the payment of the cost of the new retort-bench. The Gas Department was in a most satisfactory condition. The accounts were adopted. Bailie Smith, the Convener of the Gas Committee, moved that the price of gas be 2s. 11d. per 1000 cubic feet, as from May 15 last. In his opinion, they were perfectly safe with this price, as they were likely to have an unusually favourable year. The motion was agreed to. This restores the price of gas to what it was before June of last year, when it was raised to 3s. 1½d.

The Carnoustie Town Council are making a second endeavour to acquire the gas undertaking within the burgh. On Wednesday evening, a special meeting of the Council was held to consider the subject. Ex-Provost Soutar said the time was opportune for their dealing with the question of the taking over of the gas-works. The burgh was now in a much more favourable position for this step than it was in 1900. At the present time the community were entirely in the hands of the Gas Directors. Fortunately for them, the gas-works were well conducted; but they might not always be so. Mr. Soutar mentioned Monifieth and Newport as examples where gas-works were being successfully run by burghs. The works had been growing in value, and he thought that growth would go on, and the works become a more valuable asset for the Council. The financing would prove an easy matter. In 1900 the Council offered £10,919 for the concern; and the Company were then prepared to accept something under £12,000. At that time the total value, according to the balance-sheet, stood at £8793; but since then considerable improvements had been effected, and the value now, according to the 1908 balance-sheet, stood at fully £10,000. Mr. Rae seconded the motion for the adoption of the Burghs Gas Supply (Scotland) Act of 1876; and after a favourable expression of opinion from the councillors, the motion was agreed to unanimously.

A very pronounced grumble regarding the gas supply comes from Kirkcaldy. At a meeting of the Town Council on Monday, Mr. Wright said he had a very serious matter to bring before the Council in regard to the gas supply within the burgh. He had had many complaints all over the town regarding the light; but he did not need these complaints, as he himself had experienced the defective light in his own house. Something ought to be done by the Council to try and effect a remedy. He gave notice for next meeting that a Committee be appointed to consider and report on the advisability of the Council taking up the question of supplying the community with gas light, as the present supply was insufficient in quantity and injurious in quality; the present Gas Company having failed to keep up to the needs of the community. Mr. Miller said he had a complaint from one of his tenants about the deficiency of the gas. He could not see at night to read or write; and the gas-pipes were just the usual size, and not very long put in.

In the Lochmaben Town Council this week, a letter from the Gas Company was read in reply to a communication from the Council asking the Company to contract for gas for street lighting on special terms. The letter stated that owing to the high price of coal a reduction could not be made this year. Mr. Easton considered that the terms on which gas was supplied to the town were very unsatisfactory. The Hospital got gas at 6s. per 1000 cubic feet; and he had hoped that the same terms might be extended to the Town Council. Mr. Barbour said he had it from an electrical engineer that the town could be lighted by electricity for a total expenditure of £200, and that the light would cost only 2d. per hour. The Council, however, agreed to accept the Gas Company's supply of gas at 6s. 6d. per 1000 cubic feet, and to place a private meter on a lamp to check the existing meter.

The Directors of the Stonehouse Gas Company, Limited, have reduced the price of gas from 4s. 2d. to 3s. 11½d. per 1000 cubic feet. This is the lowest price ever charged by the Company.

CURRENT SALES OF GAS PRODUCTS.

Sulphate of Ammonia. LIVERPOOL, *Sept.* 19.

The market has been very quiet during the week, direct orders have been scarce, and, supplies having been more than ample to meet the demand, producers have been obliged to submit to some reduction in prices. The figures realized have been somewhat irregular; and at the close quotations may be called £11 3s. 9d. per ton f.o.b. Hull, £11 6s. 3d. per ton f.o.b. Liverpool, and £11 7s. 6d. to £11 8s. 9d. per ton f.o.b. Leith. The quiet spot market has reacted upon the forward position, and buyers have not shown any disposition to pay prices in the neighbourhood of £12 per ton which were recently asked by sellers.

Nitrate of Soda.

This article is weak, and spot quotations are 9s. 10½d. per cwt. for 95 per cent., and 10s. 1½d. for refined quality.

Tar Products. LONDON, *Sept.* 21.

There is little alteration in the markets for tar products, but pitch is decidedly firmer, and there are inquiries for creosote in every direction. In pitch, prices have improved during the last few days. In London, manufacturers are practically out of the market for the present, and the figures quoted are purely nominal. On the east coast, some business has been done for prompt delivery at 18s. 6d. and 19s.; but the majority of manufacturers are not sellers, and it is understood that 19s. 6d. has been offered and declined for delivery to the end of March next. On the west coast, there is a very fair demand for delivery

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to the end of the year, and 20s. is reported to have been paid in Liverpool. Creosote is firm. In London, 2¾d. has been paid for prompt delivery, and the majority of manufacturers ask now 2⅞d. and 3d. for delivery to the end of the year. In the Midlands, business has been done freely at 2¾d.; and this figure is stated to have been paid for delivery all over 1909. In the Yorkshire district, manufacturers report having declined 2⅝d., and in some cases 2¾d., and are now asking 2⅝d. for delivery to the end of June next. Benzol is still quiet for both prompt and forward delivery. There is some inquiry for 50-90 per cent. over the next twelve months; but buyers will not pay the price asked by makers. Toluol is rather better for delivery to the end of the year; one or two parcels having been sold lately in the North at 8d. to 8¼d. per gallon. In London, 8½d. is asked. Solvent naphtha is steady without alteration in price. Carbolic acid is weak, and it is impossible to sell this article for prompt delivery; while for January-June very low figures are talked of. Naphthalene is quiet, and orders are difficult to obtain. Salts are steady; but there is not much demand for same. Owing to an error, the price for tar was omitted from last week's report; but it was unchanged at 11s. 6d. to 15s. 6d.

The average values during the week were: Tar, 12s. to 16s., *ex* works. Pitch, London, 19s. to 20s.; east coast, 18s. 6d. to 19s. 6d.; west coast, 18s. 6d. to 20s., f.a.s. Benzol, 90 per cent., casks included, North, 6½d.; London, 7d. to 7¼d.; 50-90 per cent., casks included, North, 7d.; London, 7¼d. to 7½d. Toluol, casks included, North, 7⅞d. to 8d.; London, 8d. to 8½d. Crude naphtha, in bulk, North, 3d. to 3⅛d.; London, 3¼d. to 3⅜d.; solvent naphtha, casks included, North, 9d. to 9½d.; London, 10d. to 10⅛d.; heavy naphtha, casks included, North, 9d. to 9½d.; London, 10d. to 10½d. Creosote, London, 2¾d. to 2⅞d.; North, 2⅝d. to 2¾d. Heavy oils, in bulk, 3d. to 3⅛d. Carbolic acid, 60 per cent., casks included, east coast, 1s. 2½d. to 1s. 3d.; west coast, 1s. 2d. to 1s. 2½d. Naphthalene, £4 to £8; salts, 32s. 6d. to 35s., packages included and f.o.b. Anthracene, "A" quality, 1½d. to 1⅝d. per unit, packages included and delivered.

Sulphate of Ammonia.

This article is dull, and there is little business doing in same. The Gas Companies still maintain their price, but ordinary London makes could probably be bought at £11 5s. upon Beckton terms. In Hull, business has been done at £11 5s.; and in Liverpool, at £11 6s. 3d. to £11 7s. 6d. In Leith, the price asked by makers has no interest to dealers.

COAL TRADE REPORTS.

Northern Coal Trade.

There is a less demand for steam coals, but that for gas coals is now increasing. In the steam coal trade, the approaching end of the Baltic season is lessening the forward demand, and is tending to lower prices. Best Northumbrian steams are about 13s. 6d. per ton f.o.b. for prompt delivery, and a little lower for forward sales. Second-class steams are from 11s. 3d. to 12s. 6d., and steam smalls from 5s. 3d. to 6s. 3d. The output of the collieries is well taken up generally. In the gas coal trade, the exports are fair, and the home trade shows that increase in the demand usual at this season. Durham gas coals vary in price from 10s. to 11s. 3d. per ton f.o.b. for the usual qualities, and up to about 11s. 9d. for "Wear specials." There are no important contracts reported this week; but some forward sales have been made for export in the early months of next year. The prices for such are said to be nearly equal to the current quotations. In the coke trade, the demand is steady, and gas coke is firm—as high as 17s. per ton f.o.b. being quoted for some kinds of gas coke.

Scotch Coal Trade.

Trade is still vacillating. The foreign demand for current needs shows signs of slackening, and forward contracting for abroad is not very strong. The home request is improving, but only slightly. The prices quoted are: Ell 10s. 9d. to 12s. 6d. per ton f.o.b. Glasgow, splint 11s. to 11s. 3d., and steam 10s. 3d. to 10s. 6d. The shipments for the week amounted to 337,947 tons—an increase of 6634 tons upon the previous week, and of 50,760 tons upon the corresponding week of last year. For the year to date, the total shipments have been 9,983,349 tons—a decrease upon the corresponding period of 359,444 tons.

NEW CATALOGUES.

Messrs. Siemens Brothers Dynamo Works, Limited, of York Street, Westminster, have just issued a new price-sheet giving illustrated particulars of their "Solar" fittings for Tantalum "Sun" and spherical carbon filament lamps.

We have received from the Bland Light Syndicate, Limited, of No. 29, Little Trinity Lane, E.C., a copy of their catalogue of gas-burners, fixtures, and fittings for the forthcoming lighting season. Some of the firm's latest pattern lamps were illustrated on p. 717 of our last issue; and therefore it is merely necessary to remark here that the inverted lights and fittings described in the catalogue cover a wide range.

The illustrated catalogue for the season 1908-9 of the Wholesale Fittings Company, Limited, of No. 30, Commercial Street, E., furnishes full descriptions of the "Ezol," "New Ezol," "Starko," and "Transpero" inverted lamps, which were noticed in last week's "JOURNAL," besides numerous other patterns, both upright and inverted, suitable for inside and outside lighting, under all sorts of conditions. Other sections deal with mantles, French hard glass (Silchrome brand), chimneys, globes, fittings, and accessories. The Company also stock heating stoves, boiling-rings, grillers, and ovens.

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Rate Aid v. Reserve Fund at Colwyn Bay.

When the report of the Public Auditor (Mr. W. Griffith) upon the finances of the Colwyn Bay Urban District Council for the past year was before the members, Mr. Morgan pointed out that the Auditor expressed the opinion that, under the Council's Gas Act, no part of the profits of the undertaking could be appropriated to the relief of the rates till a reserve fund had been created. He had previously warned the Council of this provision in the Act; but they had chosen to disregard the warning. Mr. Bevan, the Chairman of the Finance Committee, said that the object of the promoters of the Act—the members of the Council at the time of its being passed—was to obtain as much revenue as possible from the undertaking to help them to tide over the crisis which they knew would have to come in the history of the town, when the full burden of the heavy capital expenditure would have to be borne. This was his object; and he thought he had more to do with the purchase of the gas-works than any other individual in Colwyn Bay. He could foresee the time when the money would be really wanted to keep the rates at a reasonable figure. He knew of the dispute among the legal gentlemen as to whether the Act actually carried out such an intention; and he was now prepared to allow it to be ended, as he thought the time had come when they might begin the accumulation of a reserve fund without raising the rates. They had got over their financial troubles, and their difficulties would be much easier in the future than they had been in recent years. Therefore he thought that, before the rates were reduced, they should see that a reserve fund was accumulated—to some extent, at any rate.

Cardiff and the Proposed Severn Tunnel Water Supply.

The Cardiff Water Committee, after fully considering the matter, have come to the conclusion that, "having regard to the results of the independent analysis of the water and the high percentage of hardness thereby disclosed, to the fact that the Great Western Railway Company will not guarantee a permanent and regular supply, and to the further fact that the Railway Company may divert the water, so leaving the city without such a supply, to the cost of the water after treatment for hardness, and to the reports of the Medical Officer of Health (Dr. Walford) and the Water-Works Engineer (Mr. C. H. Priestley) upon the water, the scheme of a Severn Tunnel supply of water to the city is wholly impracticable." The suggestion in the first place was that, in lieu of going to the heavy expenditure which would be involved in the construction of a third large reservoir at the Beacons, Cardiff might secure an adequate and much cheaper supply from the Great Western Railway Company, who at present are turning back into the river most of the water pumped from springs and the bed of the Severn Tunnel at Sudbrook. Mr. W. R. Bird, the Company's Analyst, reported that the minimum quantity of pure spring water pumped in any one day since the opening of the tunnel was 7,700,000 gallons, and the maximum 19,100,000 gallons. The drainage from the tunnel was separately collected, and not mixed with the spring water, which he described as perfectly sterile and absolutely free from organic contamination—there being no purer, less harmful, or more palatable water in existence. It was, he said, moderately hard, but not too hard for a town supply. Independent analyses made at the Cardiff and County Public Health Laboratory indicated that the spring water showed a total hardness of 38°, and more than 14° of permanent hardness, due to over 9 per cent. of chlorine. The treated water showed that the hardness had been reduced to 11·2°. Mr. Priestley estimated that the capital and revenue expenditure per 1000 gallons would be: Pumping, 0·75d.; paid to Great Western Railway Company, 0·75d., or 1½d. per 1000 gallons, which meant £6 5s. per million gallons; and, assuming the use of 3 million gallons a day, equalled £6846 per annum. A capital expenditure of £150,000 would need £8250 per annum in loan charges and interest at 5½ per cent. The total expenditure would thus be £15,096, which would make the cost per 1000 gallons in the Lisvane reservoir equal to 3·28d. In addition to this, there would be the cost of the distribution mains and of the softening plant.

Bye-Passing the Meter.—A proprietor of baths at Accrington, named Ainsworth, was last week fined £3 and costs, and ordered to pay £2 as damages, for fraudulently abstracting gas. It was stated that the offence was brought to the knowledge of the authorities through an anonymous letter. An Inspector, who afterwards visited the defendant's premises, found that a tap had been attached to the inlet-pipe of the meter, and a rubber pipe carried from it to a pipe on the consumer's side, so that the gas going through the rubber pipe was not registered. The contrivance had, it appeared, been in use six months; and it was also pointed out that one of the defendant's sons was connected with the gas-fitting department of a local firm.

Bridgwater Gas Company.—In the seventy-fourth annual report, which was presented at last week's meeting of the Bridgwater Gas Company, the Directors congratulated the stockholders on the continued expansion and prosperity of the business. The net profit for the year to June 30 amounted to £4239, which, with the sum brought forward and an item of interest from bankers, made a total of £4980. Interim dividends at the rate of 10 per cent. per annum on the "A" stock and 5 per cent. per annum on the "B" and "C" stocks were paid for the first six months of the year, amounting to £1625; and there was a balance of £3193 remaining to be dealt with. The Board therefore recommended the payment of final dividends for the year as follows: 5 per cent. on the "A" stock, making 10 per cent. for the year; and 2½ per cent. on the "B" and "C" stocks, making 5 per cent. for the year. This would absorb £1625, and leave a balance of £1568, out of which it was recommended to carry £487 to the reserve fund, £250 to the insurance fund, and the balance of £831 to the credit of next year's accounts. During the year, additional capital to the amount of £4383 was raised by means of 4 per cent. perpetual debenture stock; and the mortgage of £1300 on the works was paid off. The sales of gas showed the satisfactory increase of 2,765,100 cubic feet over the previous year.

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